A Review of Recently Published Fingerprint Research (2016-2017)

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Introduction

- It is difficult for most examiners to keep up with articles published in so many different journals.
- This lecture provides an brief overview of a selection of articles published since mid-2016.
- Please refer to the cited articles for more detailed information.
- Conclusions expressed in this presentation are those of the manuscript authors.

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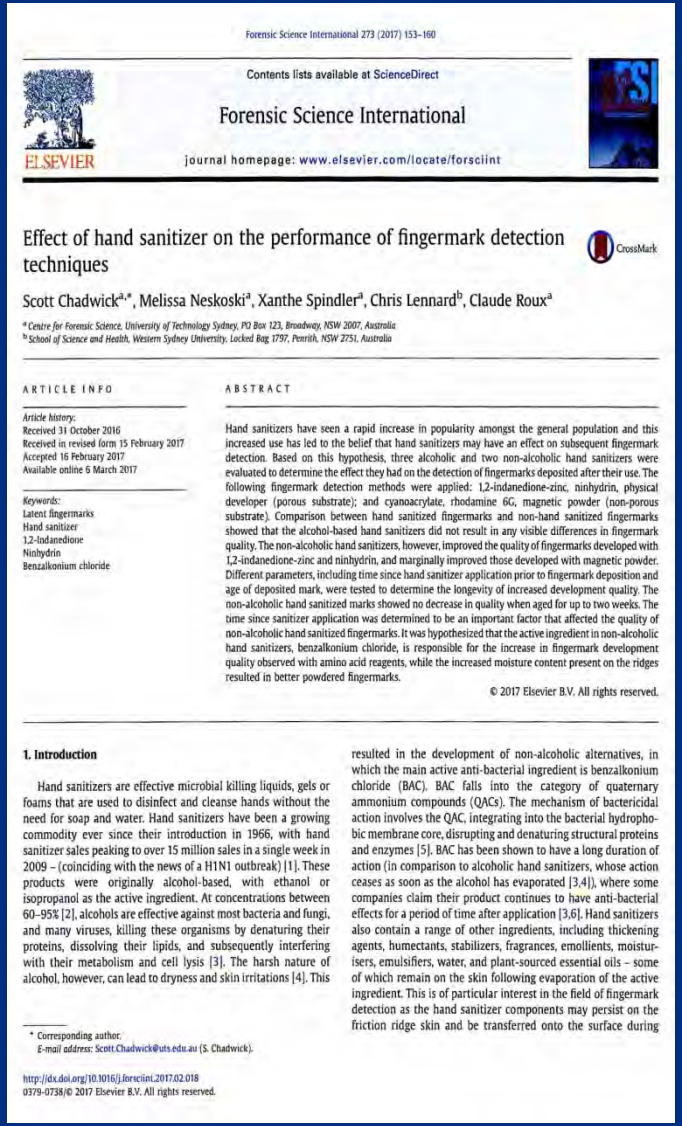
Introduction

- Chadwick et al. Effect of Hand Sanitizer on the Performance of Fingermark Detection Techniques. Forensic Sci Int 2017;273:4153-160.
- The goal of this study was to determine whether or not different hand sanitizers have an effect on several FP developers.
- Two categories of sanitizers were chosen: alcohol based and ones containing benzalkonium chloride (BAC).



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Effect of hand sanitizer on the performance of fingermark detection techniques

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ABSTRACT

Hand sanitizers have seen a rapid increase in popularity amongst the general population and this increased use has led to the belief that hand sanitizers may have an effect on subsequent fingermark detection. Based on this hypothesis, three alcoholic and two non-alcoholic hand sanitizers were evaluated to determine the effect they had on the detection of fingermarks deposited after their use. The following fingermark detection methods were applied: 1,2-indanedione-zinc, ninhydrin, physical developer (porous substrate); and cyanoacrylate, rhodamine 6G, magnetic powder (non-porous substrate). Comparison between hand sanitized fingermarks and non-hand sanitized fingermarks showed that the alcohol-based hand sanitizers did not result in any visible differences in fingermark quality. The non-alcoholic hand sanitizers, however, improved the quality of fingermarks developed with 1,2-indanedione-zinc and ninhydrin, and marginally improved those developed with magnetic powder. Different parameters, including time since hand sanitizer application prior to fingermark deposition and age of deposited mark, were tested to determine the longevity of increased development quality. The non-alcoholic hand sanitized marks showed no decrease in quality when aged for up to two weeks. The time since sanitizer application was determined to be an important factor that affected the quality of non-alcoholic hand sanitized fingermarks. It was hypothesized that the active ingredient in non-alcoholic hand sanitizers, benzalkonium chloride, is responsible for the increase in fingermark development quality observed with amino acid reagents, while the increased moisture content present on the ridges resulted in better powdered fingermarks.

1. Introduction

Hand sanitizers are effective microbial killing liquids, gels or foams that are used to disinfect and cleanse hands without the need for soap and water. Hand sanitizers have been a growing commodity ever since their introduction in 1966, with hand sanitizer sales peaking to over 15 million sales in a single week in 2009 – (coinciding with the news of a H1N1 outbreak) [1]. These products were originally alcohol-based, with ethanol or isopropanol as the active ingredient. At concentrations between 60–95% [2], alcohols are effective against most bacteria and fungi, and many viruses, killing these organisms by denaturing their proteins, dissolving their lipids, and subsequently interfering with their metabolism and cell lysis [3]. The harsh nature of alcohol, however, can lead to dryness and skin irritations [4]. This resulted in the development of non-alcoholic alternatives, in which the main active anti-bacterial ingredient is benzalkonium chloride (BAC). BAC falls into the category of quaternary ammonium compounds (QACs). The mechanism of bactericidal action involves the QAC, integrating into the bacterial hydrophobic membrane core, disrupting and denaturing structural proteins and enzymes [5]. BAC has been shown to have a long duration of action (in comparison to alcoholic hand sanitizers, whose action ceases as soon as the alcohol has evaporated [3,4]), where some companies claim their product continues to have anti-bacterial effects for a period of time after application [3,6]. Hand sanitizers also contain a range of other ingredients, including thickening agents, humectants, stabilizers, fragrances, emollients, moisturisers, emulsifiers, water, and plant-sourced essential oils – some of which remain on the skin following evaporation of the active ingredient. This is of particular interest in the field of fingermark detection as the hand sanitizer components may persist on the friction ridge skin and be transferred onto the surface during

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Protocols

- Hand sanitizers contain other ingredients including: thickening agents, humectants, stabilizers, fragrances, emollients, moisturizers, emulsifiers, water, plant-based essential oils.
- These exogenous chemicals may inhibit or enhance LP development.
- It is possible that alcohol based sanitizers could strip away sebum and lipids from the skin surface.
- The altered LP composition may change the way the LP ages.
- Ninhydrin, 1,2-IND, PD, magnetic powder, CA + R6G used.
- White copy paper (porous) and glass slides (non-porous) used.

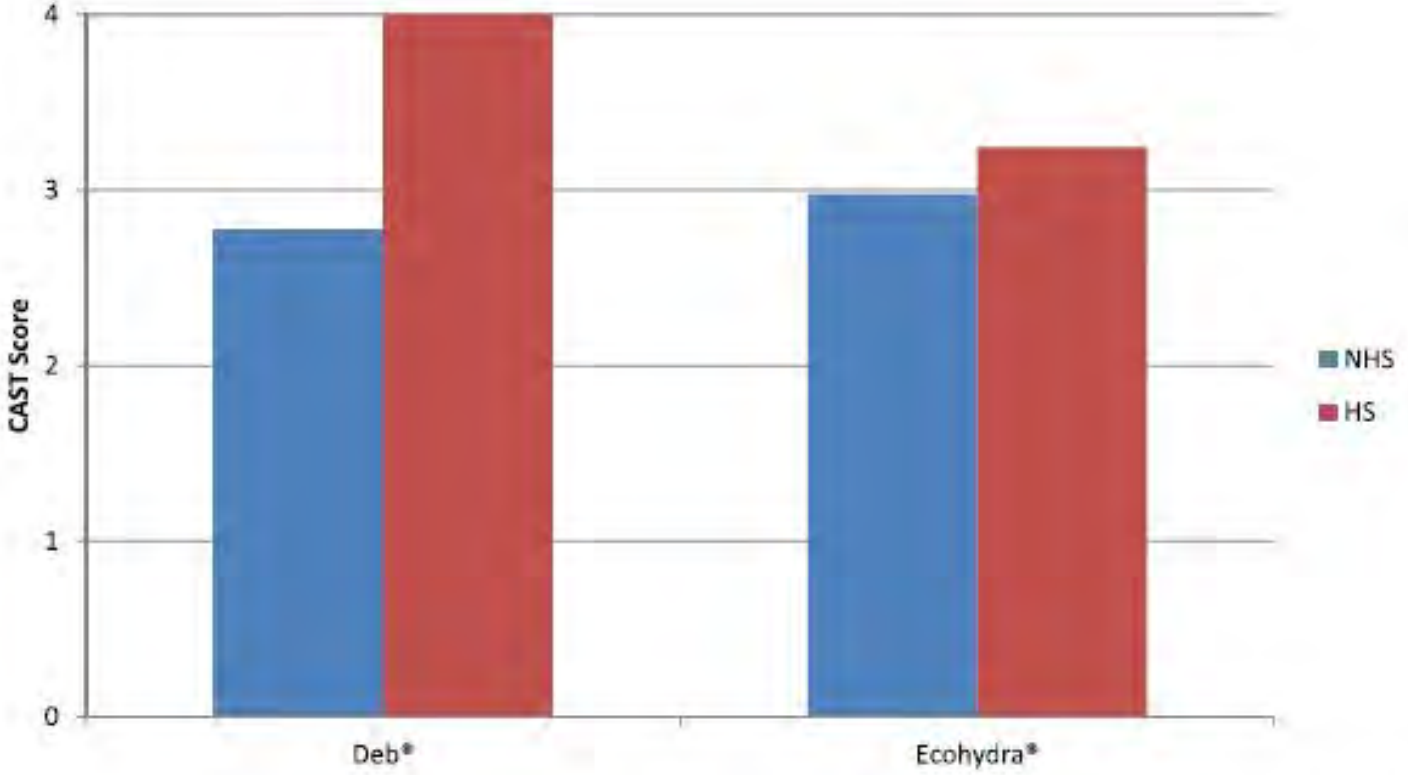


Fig. 3. Average fingermark assessment scores of all donor's EcoHydra® and Deb® HS and NHS fingermarks for black magnetic powder.

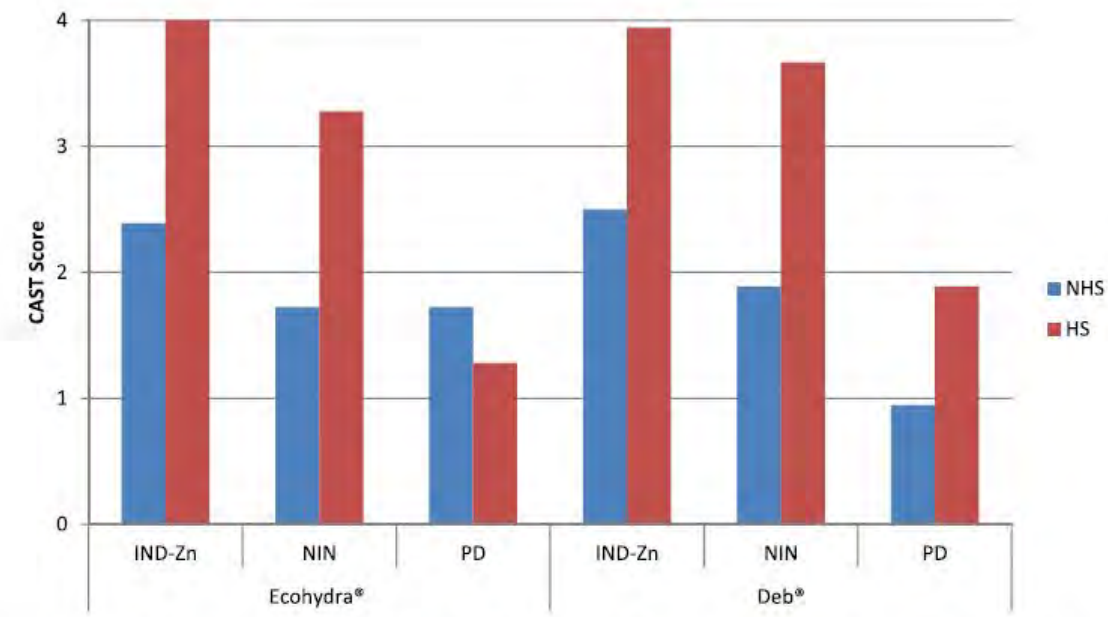


Fig. 5. Average fingermark assessment scores of all donor's EcoHydra® and Deb® HS and NHS fingermarks for each porous-surface development technique [indanedione-zinc (IND-Zn), ninhydrin (NIN) and physical developer (PD)].

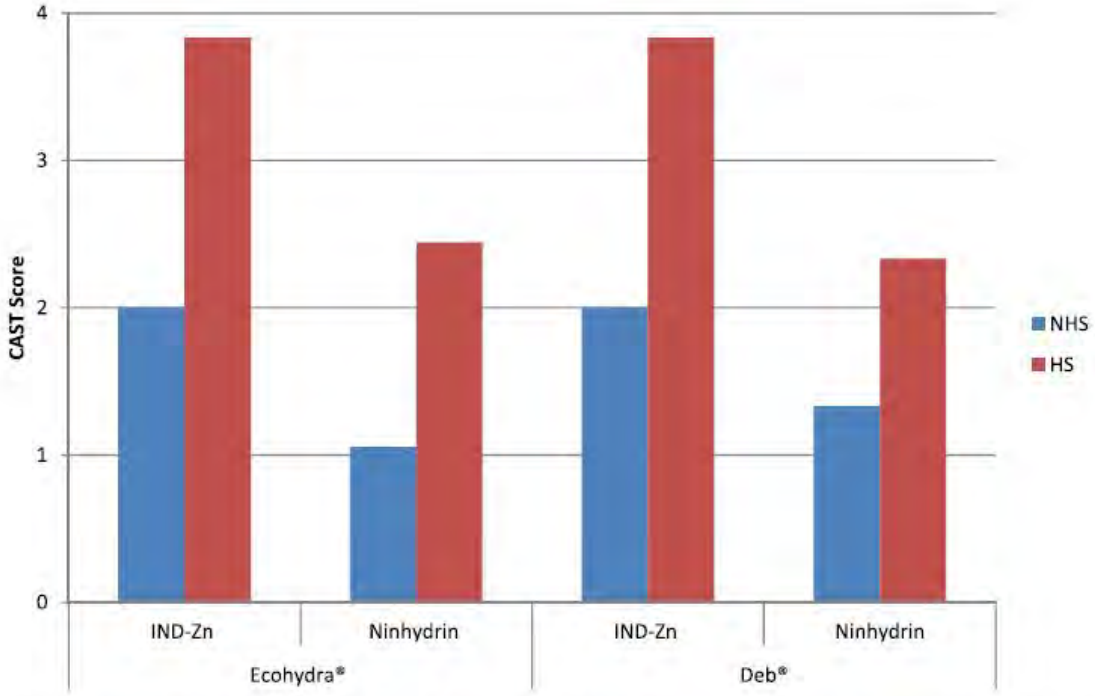


Fig. 7. Average fingermark assessment scores of all donor's EcoHydra® and Deb® HS and NHS fingermarks on samples aged for two weeks developed with either Ind-Zn or Ninhydrin.

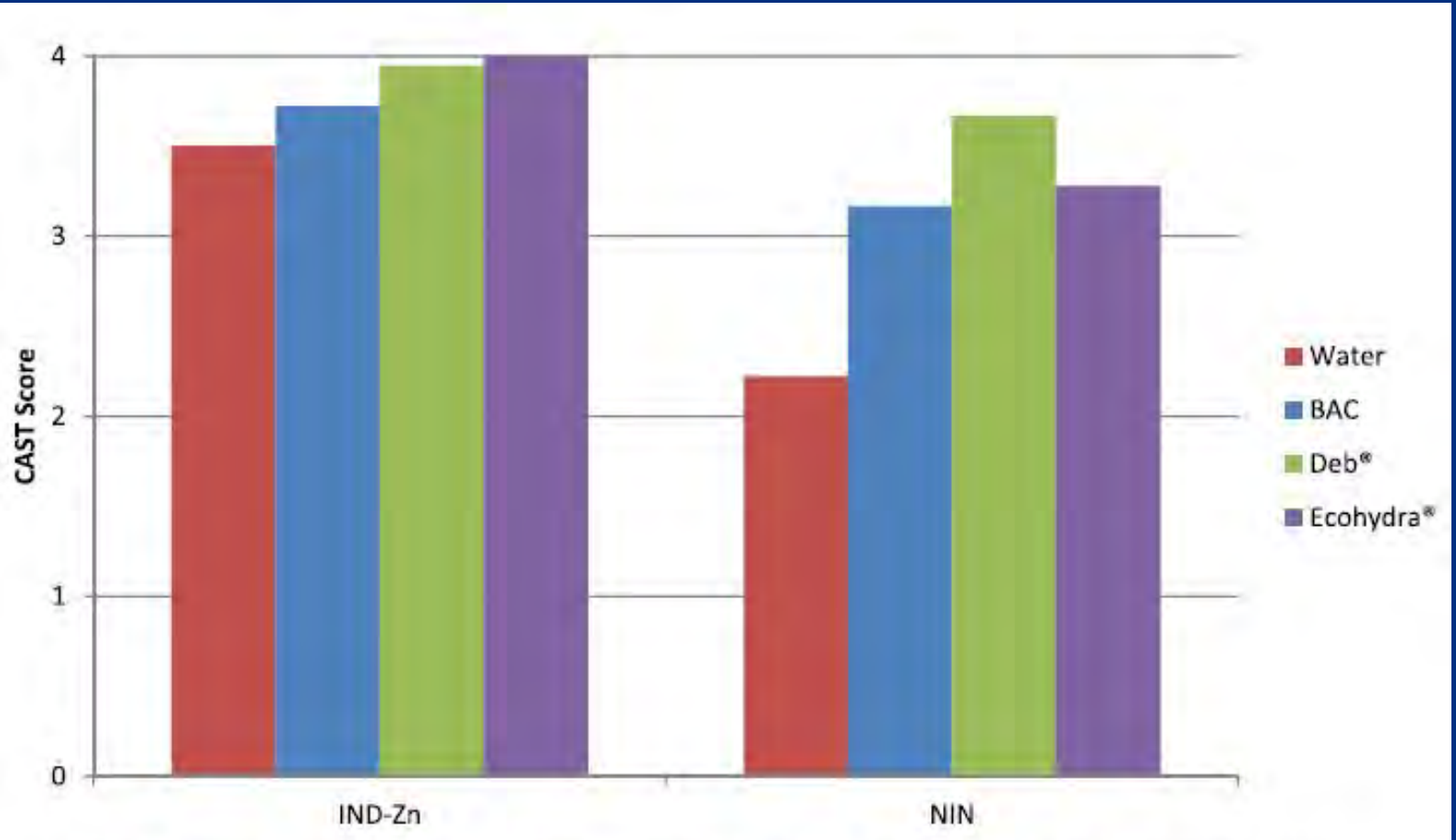


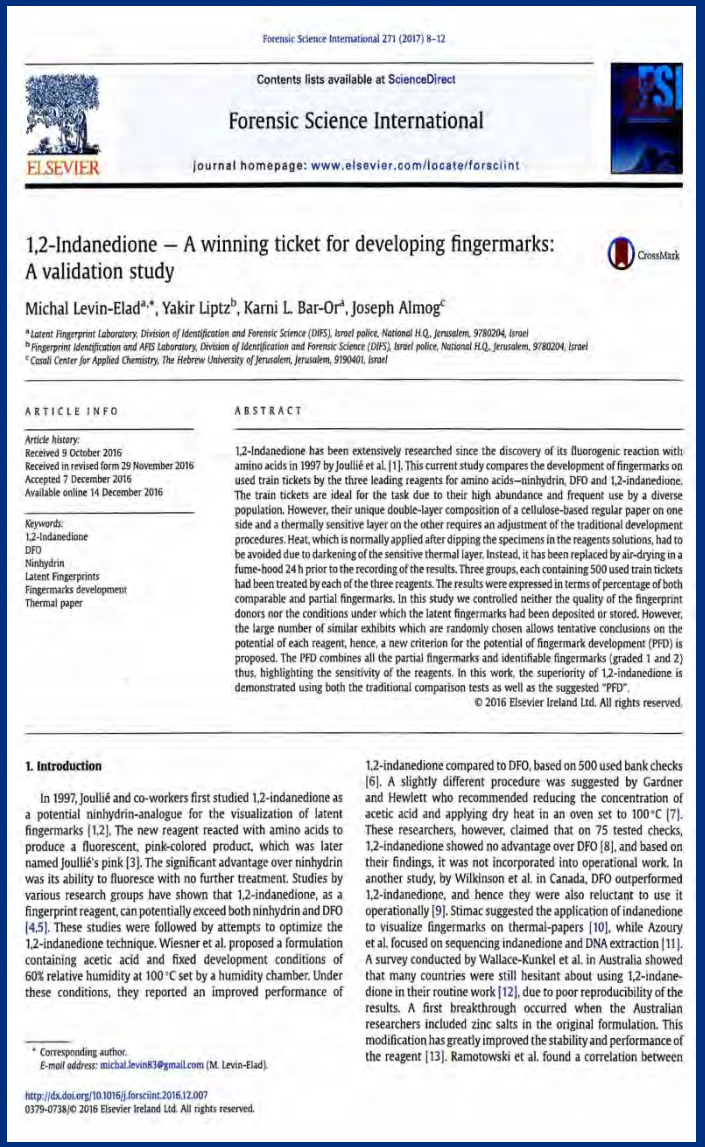
Fig. 9. Average scores for all donors from water, BAC, Deb® and Ecohydra® treated marks.

Results

- Generally, no significant difference between FP deposited after alcohol-based sanitizers.
- The use of BAC-based sanitizers generally improved the quality of prints, especially 1,2-IND and ninhydrin.
- Only marginal improvement was noted when magnetic powders were used; no difference when PD or CA-R6G used.
- The improvement from sanitizer-contaminated prints lasted only a few seconds after application.
- Overall, there is no detrimental effect on latent print visualization cause by any of the hand sanitizers.

Introduction

- Levin-Elad M et al. 1,2-Indanedione – A Winning Ticket for Developing Fingermarks: A Validation Study. Forensic Sci Int 2017;271:8-12.
- The goal of this work was to compare ninhydrin, DFO, and 1,2-IND-Zn on thermally printed train tickets.
- Traditional evaluation scales for fingerprints (see IFRG guidelines) were found to be inadequate – a new "Potential of Fingermark Development" scale was created.



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1,2-Indanedione – A winning ticket for developing fingermarks: A validation study

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Thermal paper

ABSTRACT

1,2-Indanedione has been extensively researched since the discovery of its fluorogenic reaction with amino acids in 1997 by Joullié et al. [1]. This current study compares the development of fingermarks on used train tickets by the three leading reagents for amino acids—ninhydrin, DFO and 1,2-indanedione. The train tickets are ideal for the task due to their high abundance and frequent use by a diverse population. However, their unique double-layer composition of a cellulose-based regular paper on one side and a thermally sensitive layer on the other requires an adjustment of the traditional development procedures. Heat, which is normally applied after dipping the specimens in the reagents solutions, had to be avoided due to darkening of the sensitive thermal layer. Instead, it has been replaced by air-drying in a fume-hood 24 h prior to the recording of the results. Three groups, each containing 500 used train tickets had been treated by each of the three reagents. The results were expressed in terms of percentage of both comparable and partial fingermarks. In this study we controlled neither the quality of the fingerprint donors nor the conditions under which the latent fingermarks had been deposited or stored. However, the large number of similar exhibits which are randomly chosen allows tentative conclusions on the potential of each reagent, hence, a new criterion for the potential of fingermark development (PFD) is proposed. The PFD combines all the partial fingermarks and identifiable fingermarks (graded 1 and 2) thus, highlighting the sensitivity of the reagents. In this work, the superiority of 1,2-indanedione is demonstrated using both the traditional comparison tests as well as the suggested "PFD".

1. Introduction

In 1997, Joullié and co-workers first studied 1,2-indanedione as a potential ninhydrin-analogue for the visualization of latent fingermarks [1,2]. The new reagent reacted with amino acids to produce a fluorescent, pink-colored product, which was later named Joullié's pink [3]. The significant advantage over ninhydrin was its ability to fluoresce with no further treatment. Studies by various research groups have shown that 1,2-indanedione, as a fingerprint reagent, can potentially exceed both ninhydrin and DFO [4,5]. These studies were followed by attempts to optimize the 1,2-indanedione technique. Wiesner et al. proposed a formulation containing acetic acid and fixed development conditions of 60% relative humidity at 100 °C set by a humidity chamber. Under these conditions, they reported an improved performance of 1,2-indanedione compared to DFO, based on 500 used bank checks [6]. A slightly different procedure was suggested by Gardner and Hewlett who recommended reducing the concentration of acetic acid and applying dry heat in an oven set to 100 °C [7]. These researchers, however, claimed that on 75 tested checks, 1,2-indanedione showed no advantage over DFO [8], and based on their findings, it was not incorporated into operational work. In another study, by Wilkinson et al. in Canada, DFO outperformed 1,2-indanedione, and hence they were also reluctant to use it operationally [9]. Stimac suggested the application of indanedione to visualize fingermarks on thermal-papers [10], while Azoury et al. focused on sequencing indanedione and DNA extraction [11]. A survey conducted by Wallace-Kunkel et al. in Australia showed that many countries were still hesitant about using 1,2-indanedione in their routine work [12], due to poor reproducibility of the results. A first breakthrough occurred when the Australian researchers included zinc salts in the original formulation. This modification has greatly improved the stability and performance of the reagent [13]. Ramotowski et al. found a correlation between

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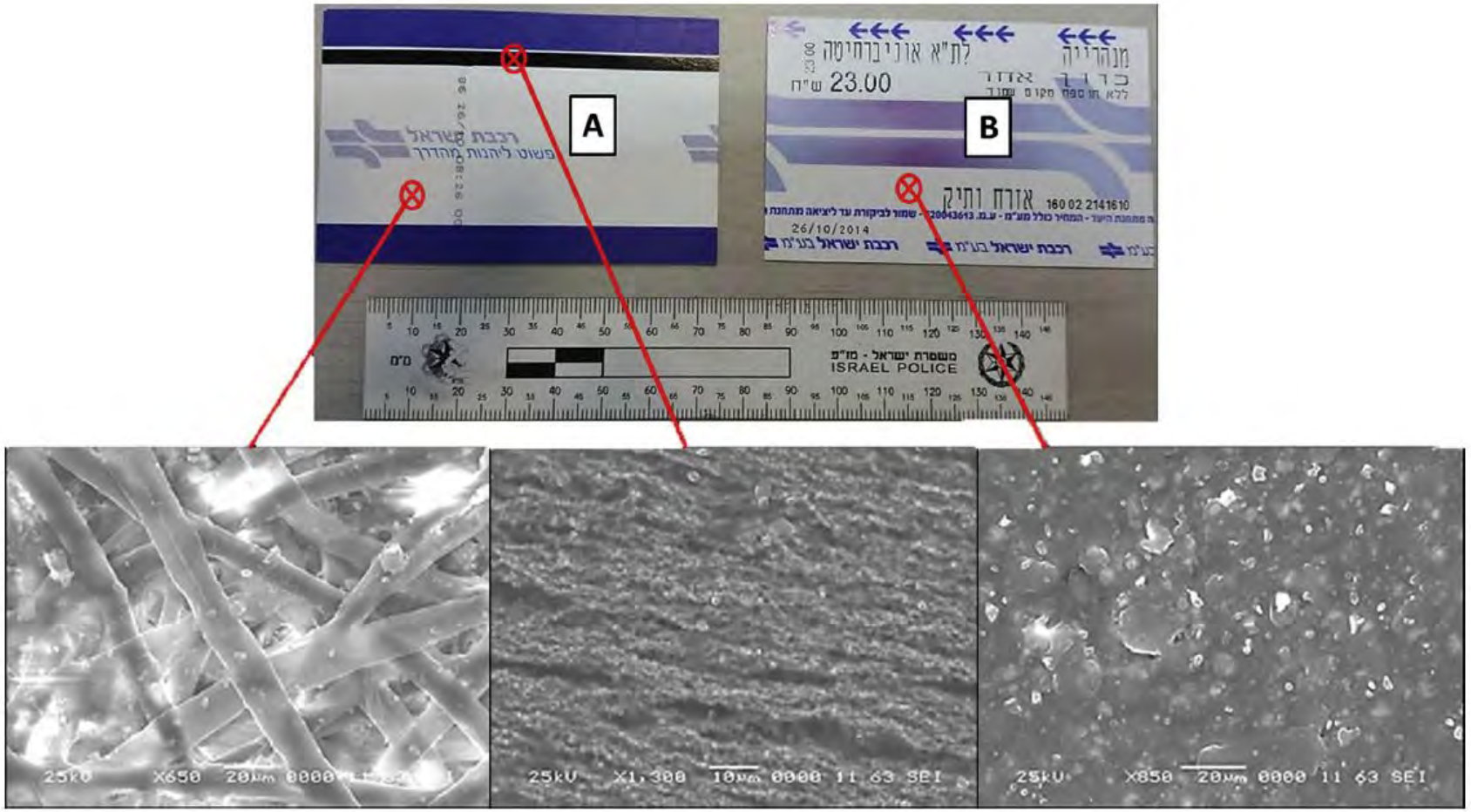
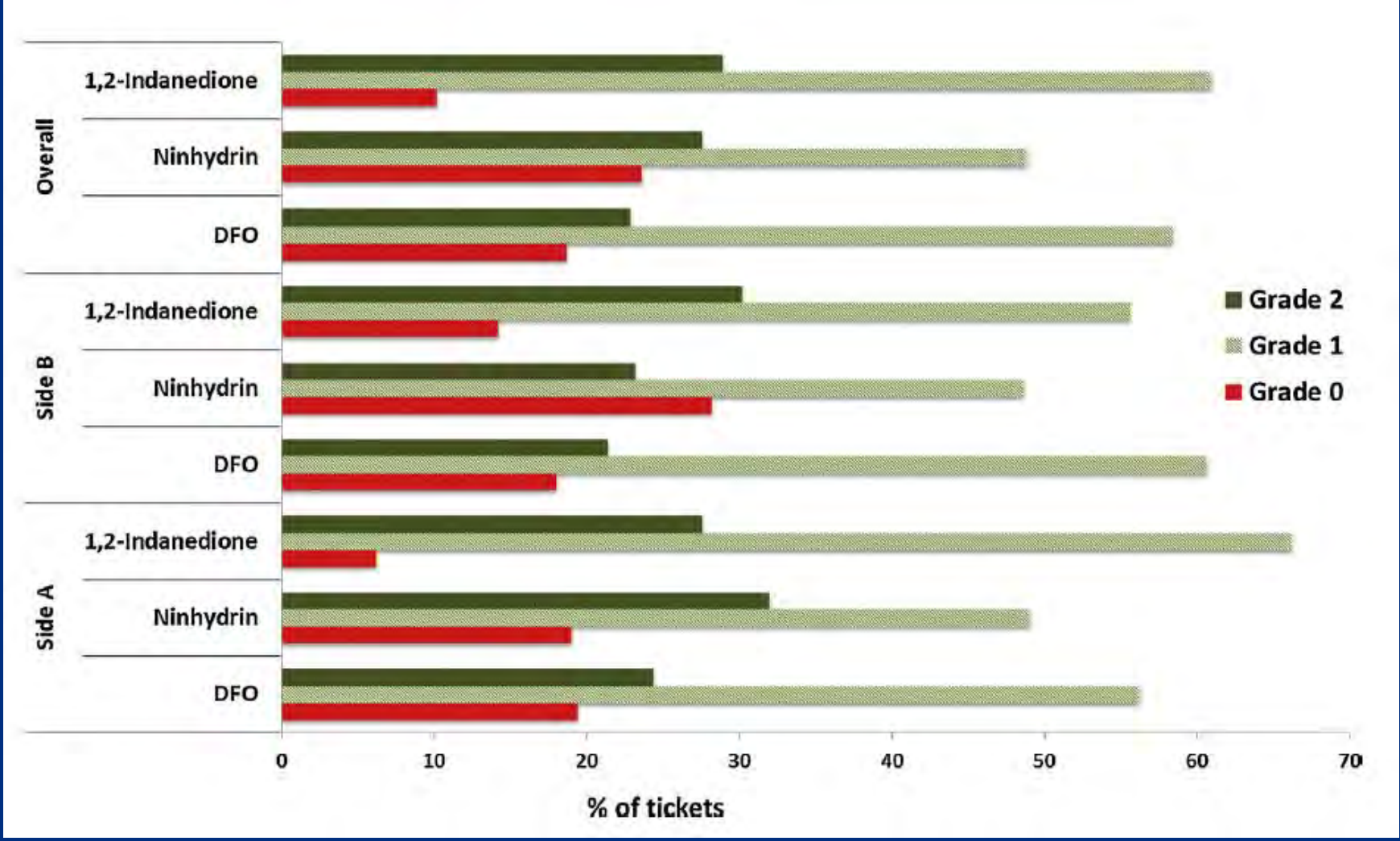
Protocols

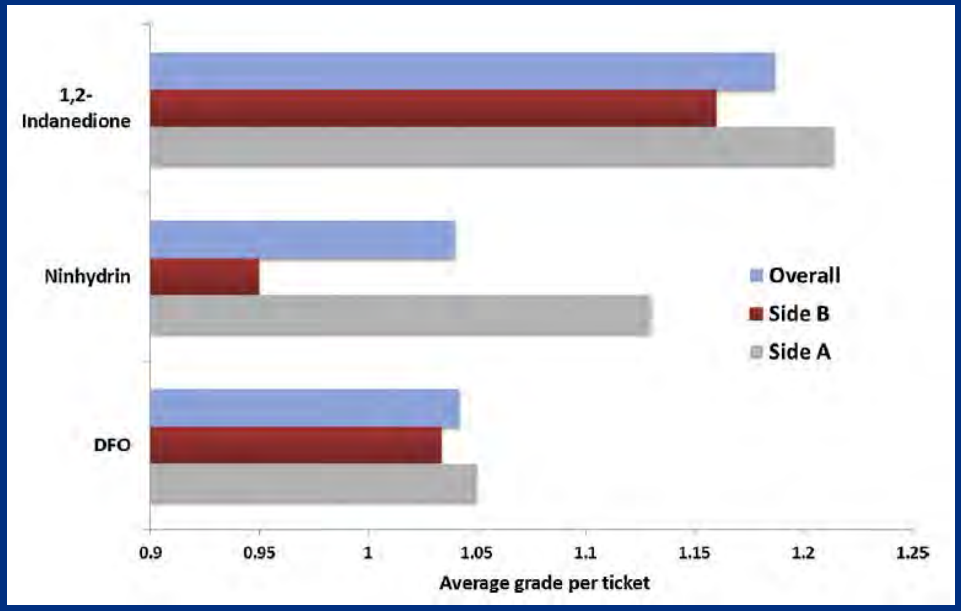
- 1500 train tickets used (collected 9-10 months prior to experiments) – grouped into 3 groups of 500 (for each method).
- Each side of the ticket was graded separately. Side A was cellulose based; side B had a thermal sensitive layer.
- The “Potential of Fingermark Development” scale refers to the overall number of partial and identifiable prints (grades 1 and 2) on each side.
- Grade zero meant no visible marks; grade 1 meant partial fingermarks – unsuitable for comparison; grade 2 meant comparable fingermarks.
- Development was done in a fume hood (no heat/24 hours).

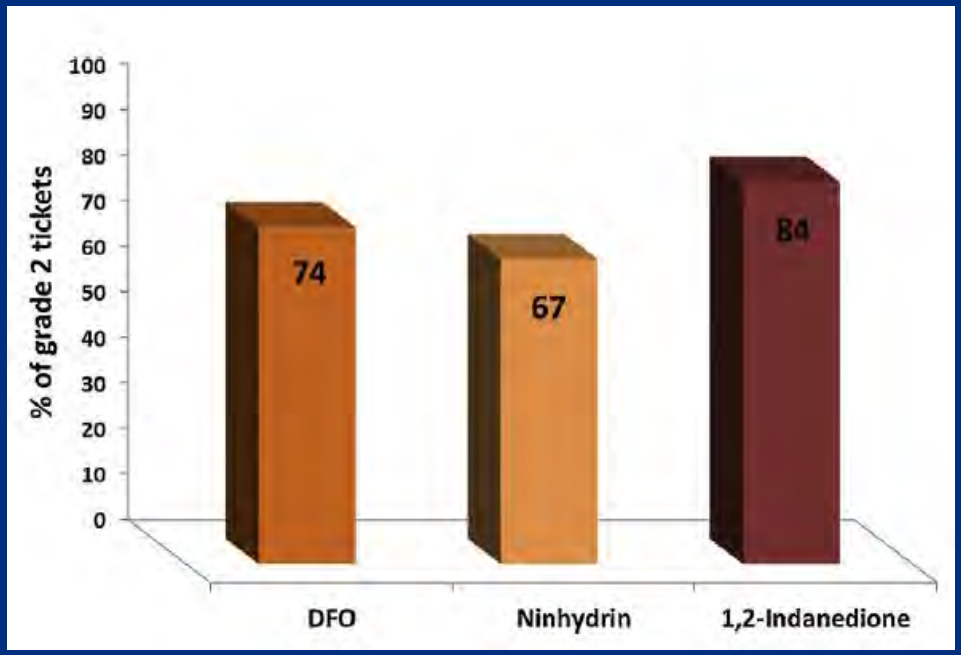

A
B
רכבת ישראל
פשוט ליהנות מהדרך
מנהרייה
ת"א אוניברסיטה
ש"ח 23.00
אזרח ותיק
160 02 2141610
26/10/2014
רכבת ישראל בע"מ
משטרת ישראל - מז"פ
ISRAEL POLICE
25kV X650 20µm 0000
25kV X1,300 10µm 0000 11 63 SEI
25kV X850 20µm 0000 11 63 SEI

Results

- For side A, ninhydrin showed a slight advantage (32% of tickets grade 2) versus 1,2-IND (28%) and DFO (24%).
- For side B, 1,2-IND was best (30%) followed by ninhydrin (23%) and DFO (21%).
- Using the new scale on side A, 1,2-IND (94%) exceeds the DFO and ninhydrin results (81% for each) .
- Using the new scale on side B, 1,2-IND (86%) again exceeds the DFO (82%) and ninhydrin (72%) results.
- 1,2-IND had the highest average grades and also had the highest number of tickets in which both sides had grade 2 level prints.

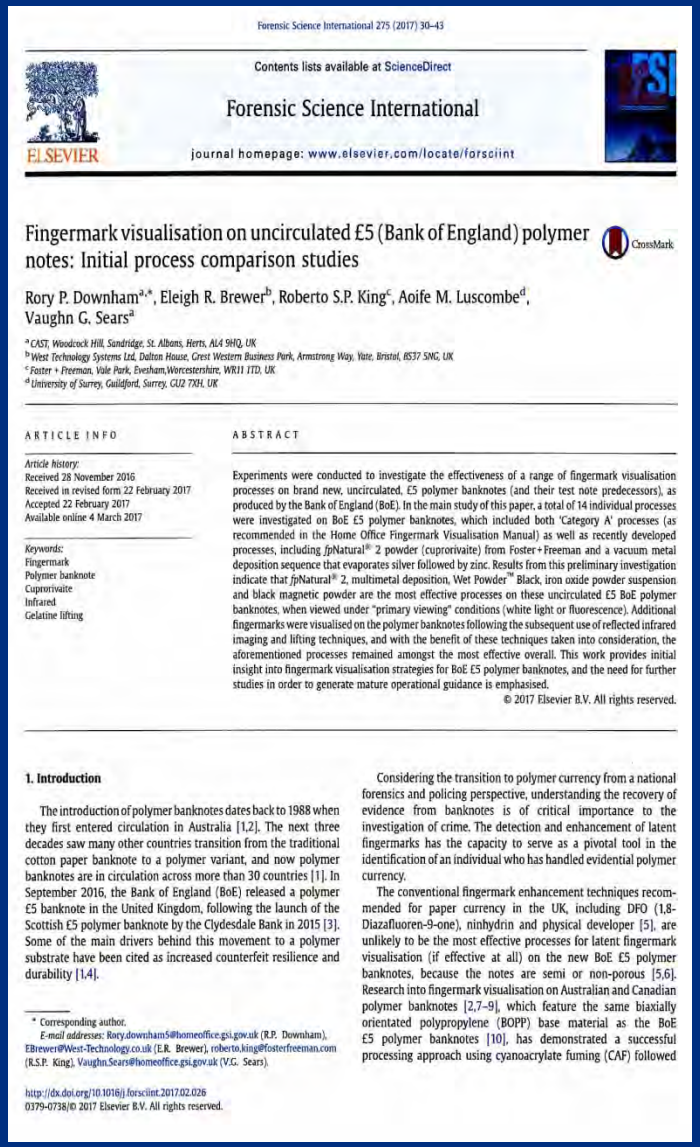

Overall
1,2-Indanedione
Ninhydrin
DFO
Side B
1,2-Indanedione
Ninhydrin
DFO
Side A
1,2-Indanedione
Ninhydrin
DFO
Grade 2
Grade 1
Grade 0
0
10
20
30
40
50
60
70
% of tickets


1,2-
Indanedione
Ninhydrin
DFO
Overall
Side B
Side A
0.9
0.95
1
1.05
1.1
1.15
1.2
1.25
Average grade per ticket


% of grade 2 tickets
100
90
80
70
60
50
40
30
20
10
0
74
67
84
DFO
Ninhydrin
1,2-Indanedione

Introduction

- Downham et al. Fingermark Visualisation on Uncirculated £5 (Bank of England) Notes: Initial Process Comparison Studies. Forensic Sci Int 2017;275:30-43.
- The goal of this work was to determine what the best methods would be for visualizing prints on Bank of England polymer banknotes.
- Although numerous countries now have polymer banknotes, visualization methods may have different levels of success in developing prints.



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Fingermark visualisation on uncirculated £5 (Bank of England) polymer notes: Initial process comparison studies

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Infrared
Gelatine lifting

ABSTRACT

Experiments were conducted to investigate the effectiveness of a range of fingermark visualisation processes on brand new, uncirculated, £5 polymer banknotes (and their test note predecessors), as produced by the Bank of England (BoE). In the main study of this paper, a total of 14 individual processes were investigated on BoE £5 polymer banknotes, which included both 'Category A' processes (as recommended in the Home Office Fingermark Visualisation Manual) as well as recently developed processes, including *fp*Natural® 2 powder (cuprorivaite) from Foster + Freeman and a vacuum metal deposition sequence that evaporates silver followed by zinc. Results from this preliminary investigation indicate that *fp*Natural® 2, multimetal deposition, Wet Powder™ Black, iron oxide powder suspension and black magnetic powder are the most effective processes on these uncirculated £5 BoE polymer banknotes, when viewed under "primary viewing" conditions (white light or fluorescence). Additional fingermarks were visualised on the polymer banknotes following the subsequent use of reflected infrared imaging and lifting techniques, and with the benefit of these techniques taken into consideration, the aforementioned processes remained amongst the most effective overall. This work provides initial insight into fingermark visualisation strategies for BoE £5 polymer banknotes, and the need for further studies in order to generate mature operational guidance is emphasised.

1. Introduction

The introduction of polymer banknotes dates back to 1988 when they first entered circulation in Australia [1,2]. The next three decades saw many other countries transition from the traditional cotton paper banknote to a polymer variant, and now polymer banknotes are in circulation across more than 30 countries [1]. In September 2016, the Bank of England (BoE) released a polymer £5 banknote in the United Kingdom, following the launch of the Scottish £5 polymer banknote by the Clydesdale Bank in 2015 [3]. Some of the main drivers behind this movement to a polymer substrate have been cited as increased counterfeit resilience and durability [1,4].

Considering the transition to polymer currency from a national forensics and policing perspective, understanding the recovery of evidence from banknotes is of critical importance to the investigation of crime. The detection and enhancement of latent fingermarks has the capacity to serve as a pivotal tool in the identification of an individual who has handled evidential polymer currency.

The conventional fingermark enhancement techniques recommended for paper currency in the UK, including DFO (1,8-Diazafluoren-9-one), ninhydrin and physical developer [5], are unlikely to be the most effective processes for latent fingermark visualisation (if effective at all) on the new BoE £5 polymer banknotes, because the notes are semi or non-porous [5,6]. Research into fingermark visualisation on Australian and Canadian polymer banknotes [2,7–9], which feature the same biaxially orientated polypropylene (BOPP) base material as the BoE £5 polymer banknotes [10], has demonstrated a successful processing approach using cyanoacrylate fuming (CAF) followed

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Protocols

- 8 donors used.
- Experiment 1: prints aged 2-3 days and 12-13 days.
- Experiment 2: prints aged 1-2 days and 12-13 days.
- Experiment 1: Precursor/test notes.
- Experiment 2: Mass production notes.

Fig. 1. One test set of notes: created for each process, per fingermark aging period (different donors, A–H, approximate positions).

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Table 1
Fingermark visualisation processes compared in Experiment 1 and/or Experiment 2 (further details relating to formulations, chemical quality and application are provided in the Electronic Supplementary Information — ESI Table 1).

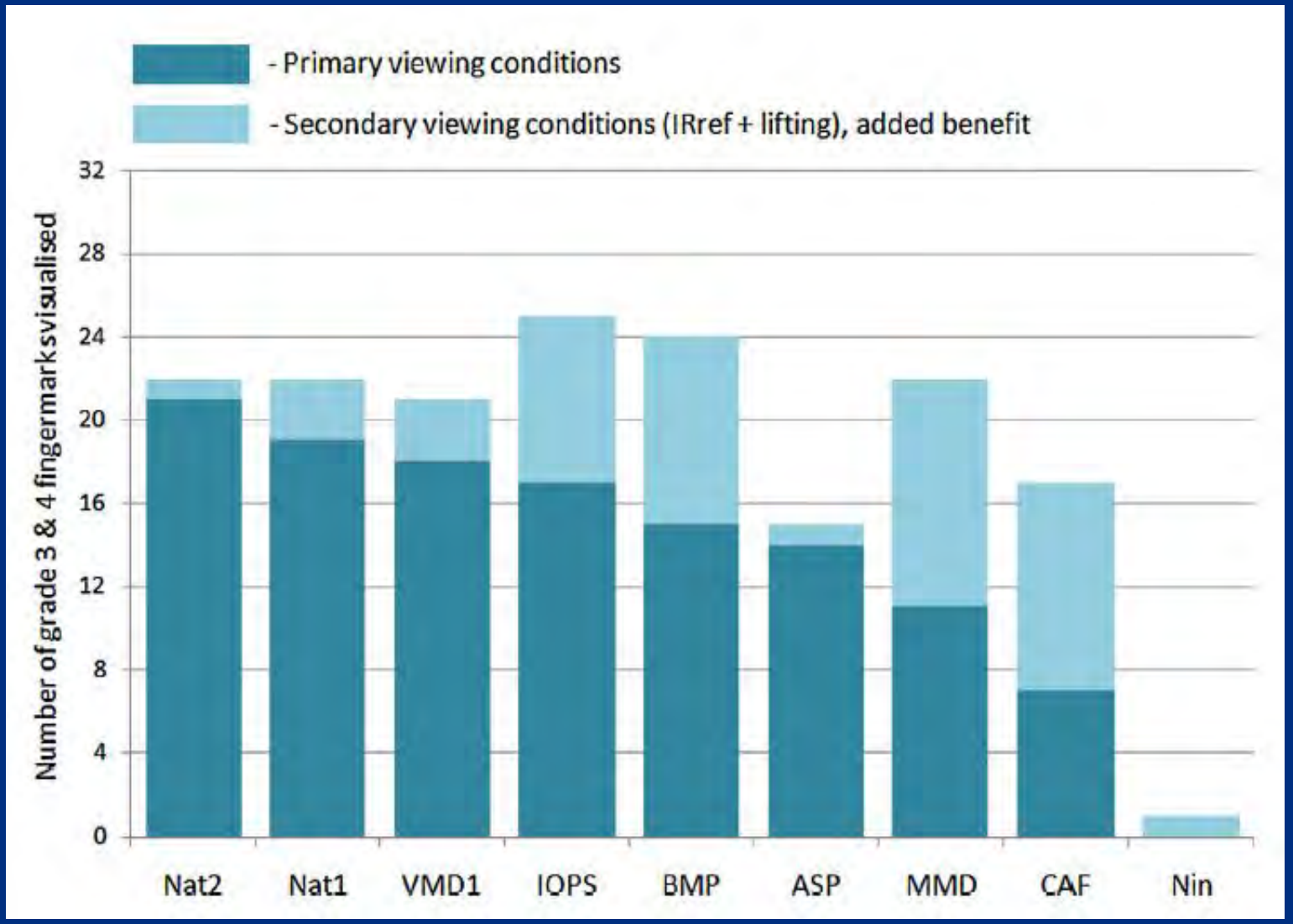
Fingermark visualisation process	Formulation, material reference, and/or manufacturer	Specialist equipment used and the manufacturer	Process application/equipment use reference(s)	Experiment process used in
Anti-stokes powder (ASP)	VISAS magnetic powder, BVDA™	Crime-lite ® Anti-Stokes Viewer (ASV), Foster + Freeman Ltd	As per the manufacturer's instructions	1
Ninhydrin (Nin)	FVM [6] formulation	Weiss FDC oven, Weisstechnik ®	As per the FVM [6]	1
Black magnetic powder (BMP)	Crime Scene Investigation Equipment Ltd	N/A	As per the FVM [6]	1 & 2
*fp*Natural® 1 powder (Nat1)	Foster + Freeman Ltd	Crime-lite ® Imager, Foster + Freeman Ltd (See Table 3 for light sources and filters used)	As per the manufacturer's instructions [29]	1 & 2
*fp*Natural® 2 powder (Nat2)	Foster + Freeman Ltd	Crime-lite ® Imager, Foster + Freeman Ltd (See Table 3 for light sources and filters used)	As per the manufacturer's instructions [29]	1 & 2
Iron oxide powder suspension (IOPS)	FVM [6] formulation	N/A	As per the FVM [6]	1 & 2
Cyanoacrylate fuming (CAF)	Cyanobloom, Foster + Freeman Ltd	MVC 5000 fuming cabinet, Mason Vactron	As per the FVM [6] and the manufacturer's instructions	1 & 2
Vacuum metal deposition: AuZn, followed by Ag (VMD1)	Gold, zinc and silver (as per FVM [6])	VMD900, West Technology Ltd	As per the FVM [6] and the manufacturer's instructions N.B. the gold-zinc method was used multiple times per sample, followed by the silver method [6]	1 & 2
Multimetal deposition (MMD)	FVM [6] formulation	N/A	As per the FVM [6]	1 & 2
Gel lifting (and scanning) (GL)	Black gelatine lifters, BVDA™	GLScan ®, BVDA™	As per the FVM [6] and the manufacturer's instructions	2
Lumicyano™ fuming (Lumi)	Crime Science Technology	MVC® 1000 fuming cabinet, Foster + Freeman Ltd (See Table 3 for light sources and filters used)	As per the manufacturer's instructions	2
PolyCyano UV fuming (PCUV)	Foster + Freeman Ltd	MVC® 1000 fuming cabinet, Foster + Freeman Ltd (See Table 3 for light sources and filters used)	As per the manufacturer's instructions	2
Small particle reagent (SPR)	FVM [6] formulation	N/A	As per the FVM [6]	2
Vacuum metal deposition: AgZn (VMD2)	Silver and zinc (as per FVM [6])	VMD900, West Technology Ltd	Method developed by Brewer [30]	2
Wet Powder™ Black powder suspension (WPB)	Kjell Carlsson Innovation	N/A	As per the FVM [6]	2
Wet Powder™ White powder suspension (WPW)	Kjell Carlsson Innovation	N/A	As per the FVM [6]	2

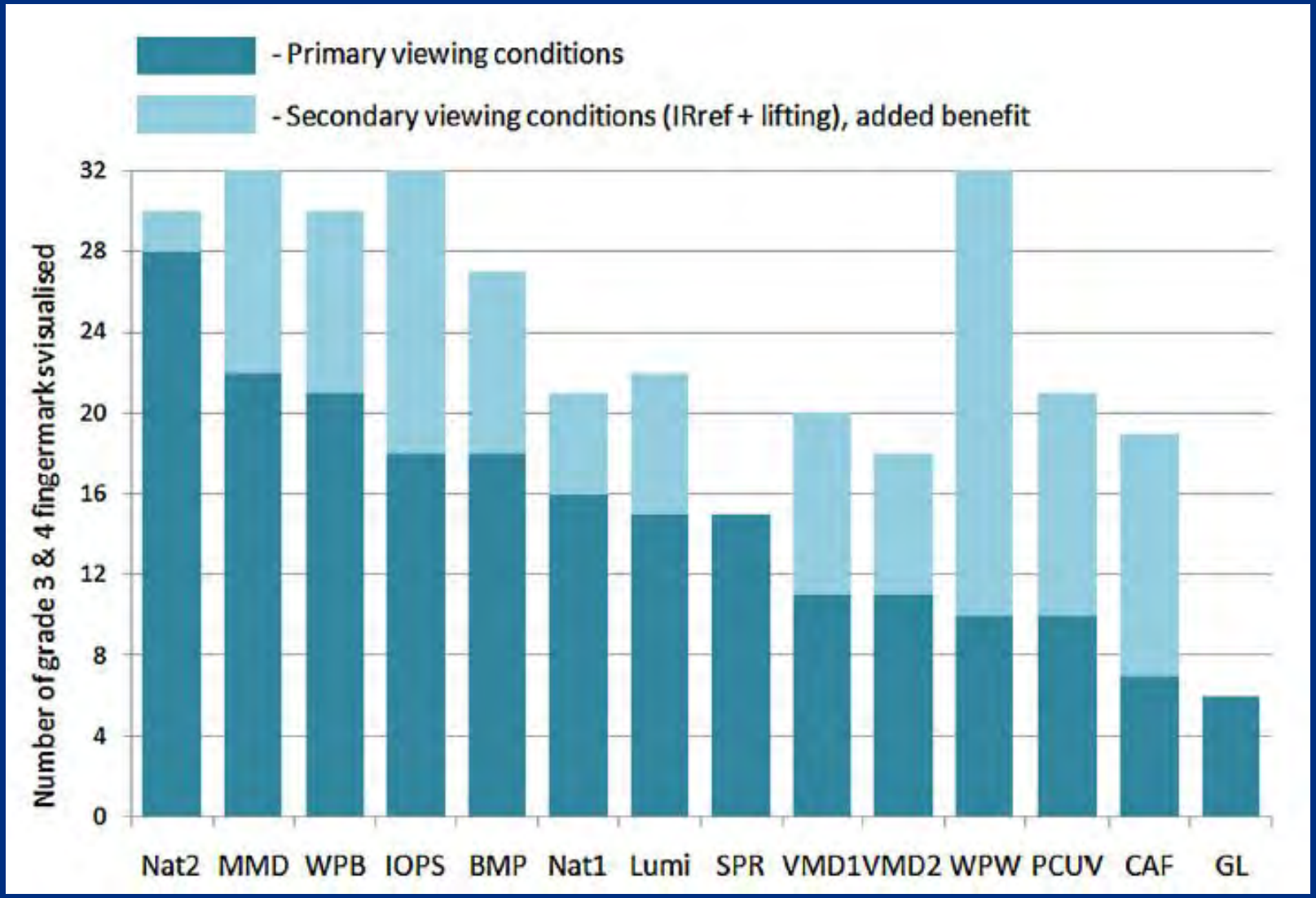
Table 3
The primary viewing and grading conditions used for each process.

Process(es)	Primary viewing conditions	Grading conditions
Nin, BMP, IOPS, MMD, SPR, VMD1, VMD2, WPB, WPW	• Reflected white light	Directly from processed banknotes, by eye
CAF	• Reflected white light • Oblique white light (Crime-lite® 80L)	Directly from processed banknotes, by eye
ASP	• Fluorescence conditions: 2 × 6W 976 nm excitation lasers (viewed through Schott KG5 IR blocking filter)	Directly from the processed banknote, by eye
Nat1	• Fluorescence conditions: - Experiment 1: 350–380 nm and 420–470 nm LED excitation sources (Crime-lite® Imager + corresponding 82S Crime-lite®), each with 715 nm LP filter - Experiment 2: 350–380 nm, 420–470 nm, and 600–650 nm LED excitation sources (Crime-lite® Imager + corresponding 82S Crime-lite®), each with 715 nm LP filter • Imaging (Experiments 1 and 2): - 5 megapixel full-spectrum monochrome camera	From images displayed on a monitor
Nat2	• Fluorescence conditions: - 730–800 nm (82S IR780 Crime-lite®) excitation source with 850 nm LP filter • Imaging: - 5 megapixel full-spectrum monochrome camera	From images displayed on a monitor
GL (and scanning)	• GLScan ® imaging	From images displayed on a monitor
Lumi	• Oblique white light (Crime-lite® 80L) • Fluorescence conditions: - 350–380 nm (82S UV Crime-lite®) excitation source, UV-blocked viewing filter - 460–510 nm (82S blue green Crime-lite®) excitation source, Schott OG550 LP viewing filter - 532 nm laser (Coherent Tracer™ Compact) excitation source, Schott OG570 LP viewing filter - 460 nm laser (Coherent Tracer™ Compact) excitation source, Schott GG495 LP viewing filter - 420–470 nm (82S blue Crime-lite®) excitation source, Schott GG495 LP viewing filter - ~365 nm ('Super Xenon' Labino) illumination, UV-blocked viewing filter	Directly from processed banknotes, by eye. 15 min dark adaptation period observed for fluorescence examination
PCUV	• Oblique white light (Crime-lite® 80L) • Fluorescence conditions: - 350–380 nm (82S UV Crime-lite®) excitation source, UV-blocked viewing filter - 460 nm laser (Coherent Tracer™ Compact) excitation source, Schott GG495 LP viewing filter - 420–470 nm (82S blue Crime-lite®) excitation source, Schott GG495 LP viewing filter	Directly from processed banknotes, by eye. 15 min dark adaptation period observed for fluorescence examination

Results

- Experiment 1: *fp*Natural 2 powder developed the most grade 3 or 4 prints with a recovery rate of 66%; CA gave the worst results (22%).
- *fp*Natural 1, VMD (Au/Zn/Ag), iron oxide powder suspension gave the next best results (recovery rate 53-59%).
- Gel lifting/GLScan® system provided more benefit than IRef (IR sensitive camera/RG780) as a secondary enhancement technique.
- Experiment 2: *fp*Natural 2 powder developed the most grade 3 or 4 prints (88%); gel lifting gave the worst results (19%).
- MMD, Wet Powder black PS, iron oxide PS, black magnetic powder and *fp*Natural 1 recovered 50-69% of prints (graded 3 or 4).
- CA fuming and VMD did not perform as well as expected.


- Primary viewing conditions
- Secondary viewing conditions (IRref + lifting), added benefit
Number of grade 3 & 4 fingermarks visualised
32
28
24
20
16
12
8
4
0
Nat2
Nat1
VMD1
IOPS
BMP
ASP
MMD
CAF
Nin


- Primary viewing conditions
- Secondary viewing conditions (IRref + lifting), added benefit
Number of grade 3 & 4 fingermarks visualised
0
4
8
12
16
20
24
28
32
Nat2
MMD
WPB
IOPS
BMP
Nat1
Lumi
SPR
VMD1
VMD2
WPW
PCUV
CAF
GL

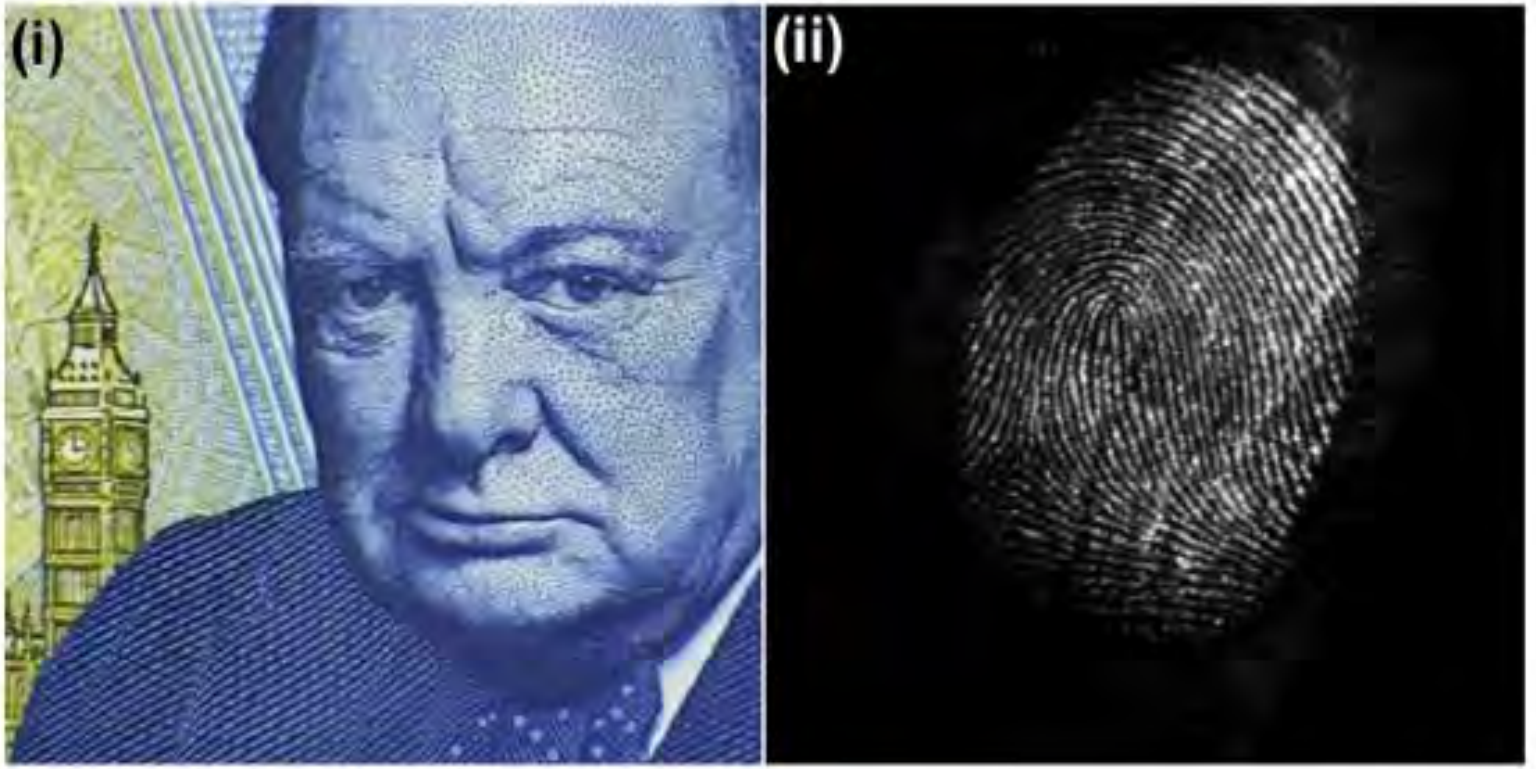


Fig. 8. Nat2 treated fingermark on BoE £5 polymer banknote; (i) as imaged under white light (not visible), and (ii) as imaged under NIR-NIR fluorescence conditions.

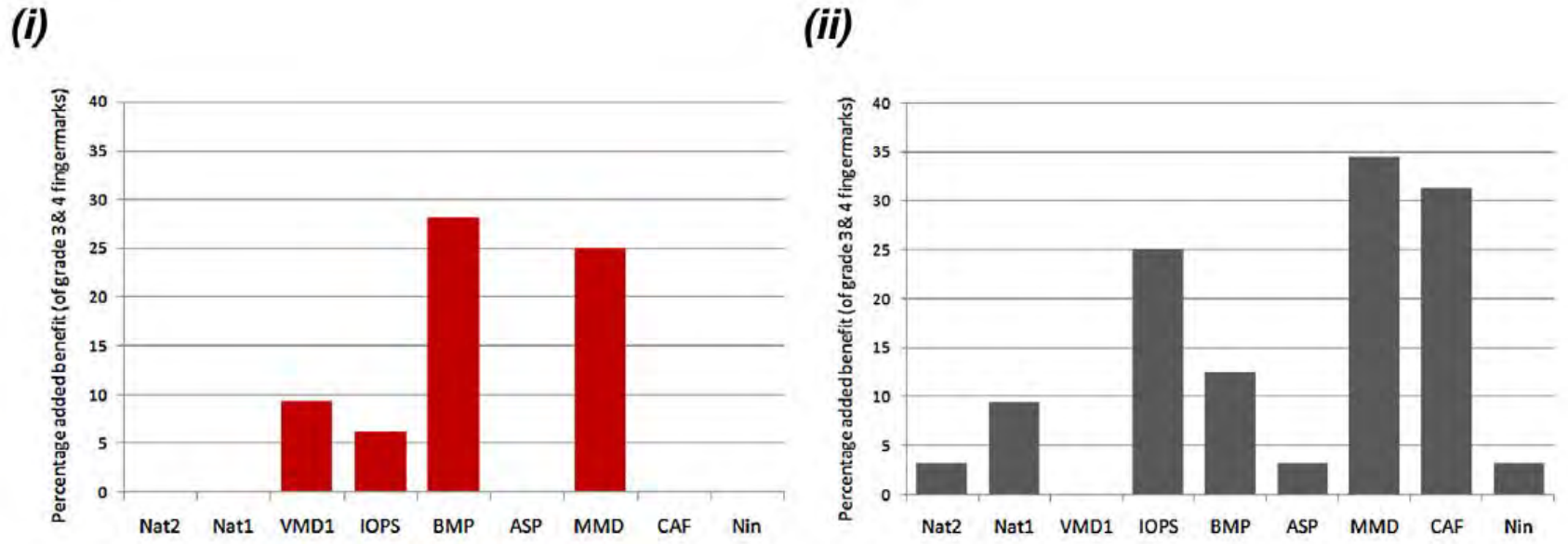
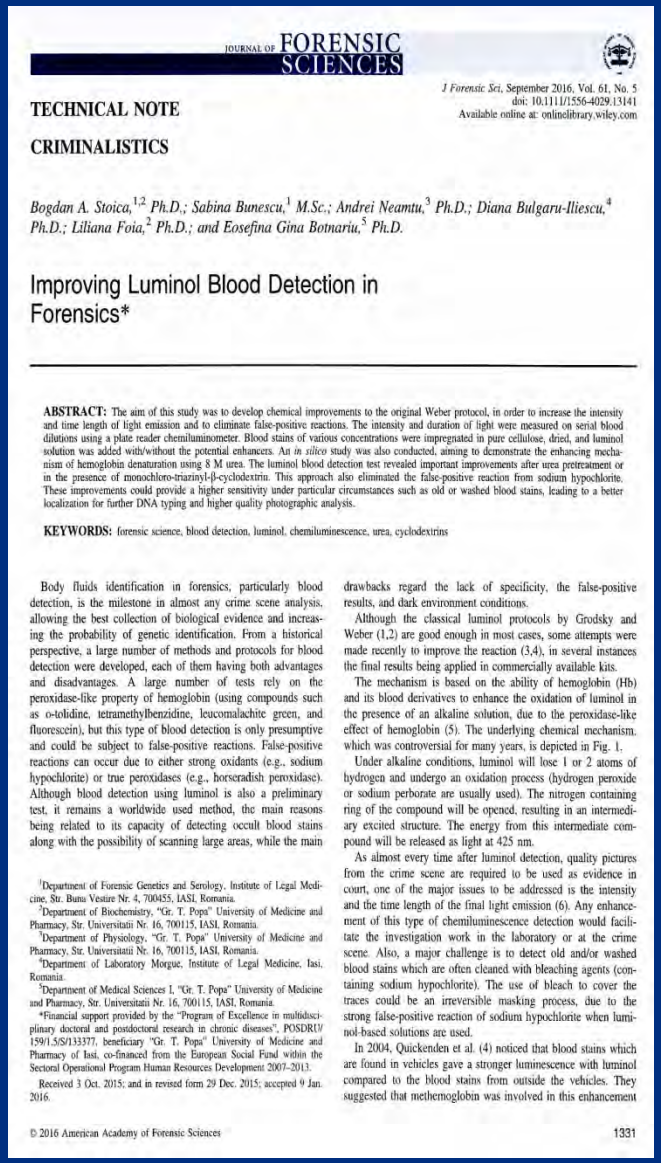


Fig. 4. The percentage added benefit of grade 3 and 4 fingermarks gained from using IRref (i), and gel lifting (ii), subsequent to primary viewing conditions in Experiment 1 (both fingermark age sets combined).

Fig. 10. A fingermark visualised with MMD (i) and WPB (ii), as viewed under white light, IRref, and from a gel lift scan (left to right).

Introduction

- Stoica B et al. Improving Luminol Blood Detection In Forensics. J Forensic Sci 2016;61(5):1331-1336.
- The goal of this work was to determine whether or not the Weber luminol formulation could be improved by adding β-type cyclodextrins and urea.
- Could the addition of these chemicals improve both the chemiluminescence intensity and duration?
- What effect would 8 *M* urea pretreatment have on hypochlorite treated blood stains?



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TECHNICAL NOTE

CRIMINALISTICS

Bogdan A. Stoica,[1,2] Ph.D.; Sabina Bunescu,[1] M.Sc.; Andrei Neamtu,[3] Ph.D.; Diana Bulgaru-Iliescu,[4] Ph.D.; Liliana Foia,[2] Ph.D.; and Eosefina Gina Botnariu,[5] Ph.D.

Improving Luminol Blood Detection in Forensics*

ABSTRACT: The aim of this study was to develop chemical improvements to the original Weber protocol, in order to increase the intensity and time length of light emission and to eliminate false-positive reactions. The intensity and duration of light were measured on serial blood dilutions using a plate reader chemiluminometer. Blood stains of various concentrations were impregnated in pure cellulose, dried, and luminol solution was added with/without the potential enhancers. An *in silico* study was also conducted, aiming to demonstrate the enhancing mechanism of hemoglobin denaturation using 8 M urea. The luminol blood detection test revealed important improvements after urea pretreatment or in the presence of monochloro-triazinyl-β-cyclodextrin. This approach also eliminated the false-positive reaction from sodium hypochlorite. These improvements could provide a higher sensitivity under particular circumstances such as old or washed blood stains, leading to a better localization for further DNA typing and higher quality photographic analysis.

KEYWORDS: forensic science, blood detection, luminol, chemiluminescence, urea, cyclodextrins

Body fluids identification in forensics, particularly blood detection, is the milestone in almost any crime scene analysis, allowing the best collection of biological evidence and increasing the probability of genetic identification. From a historical perspective, a large number of methods and protocols for blood detection were developed, each of them having both advantages and disadvantages. A large number of tests rely on the peroxidase-like property of hemoglobin (using compounds such as o-tolidine, tetramethylbenzidine, leucomalachite green, and fluorescein), but this type of blood detection is only presumptive and could be subject to false-positive reactions. False-positive reactions can occur due to either strong oxidants (e.g., sodium hypochlorite) or true peroxidases (e.g., horseradish peroxidase). Although blood detection using luminol is also a preliminary test, it remains a worldwide used method, the main reasons being related to its capacity of detecting occult blood stains along with the possibility of scanning large areas, while the main drawbacks regard the lack of specificity, the false-positive results, and dark environment conditions.

Although the classical luminol protocols by Grodsky and Weber (1,2) are good enough in most cases, some attempts were made recently to improve the reaction (3,4), in several instances the final results being applied in commercially available kits.

The mechanism is based on the ability of hemoglobin (Hb) and its blood derivatives to enhance the oxidation of luminol in the presence of an alkaline solution, due to the peroxidase-like effect of hemoglobin (5). The underlying chemical mechanism, which was controversial for many years, is depicted in Fig. 1.

Under alkaline conditions, luminol will lose 1 or 2 atoms of hydrogen and undergo an oxidation process (hydrogen peroxide or sodium perborate are usually used). The nitrogen containing ring of the compound will be opened, resulting in an intermediary excited structure. The energy from this intermediate compound will be released as light at 425 nm.

As almost every time after luminol detection, quality pictures from the crime scene are required to be used as evidence in court, one of the major issues to be addressed is the intensity and the time length of the final light emission (6). Any enhancement of this type of chemiluminescence detection would facilitate the investigation work in the laboratory or at the crime scene. Also, a major challenge is to detect old and/or washed blood stains which are often cleaned with bleaching agents (containing sodium hypochlorite). The use of bleach to cover the traces could be an irreversible masking process, due to the strong false-positive reaction of sodium hypochlorite when luminol-based solutions are used.

In 2004, Quickenden et al. (4) noticed that blood stains which are found in vehicles gave a stronger luminescence with luminol compared to the blood stains from outside the vehicles. They suggested that methemoglobin was involved in this enhancement

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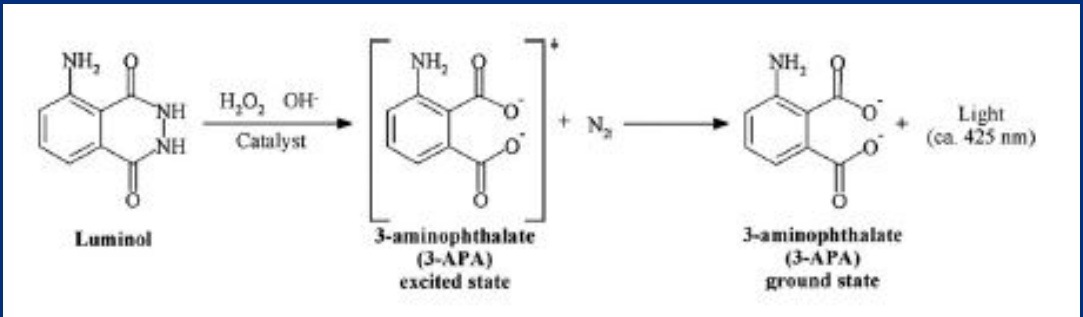
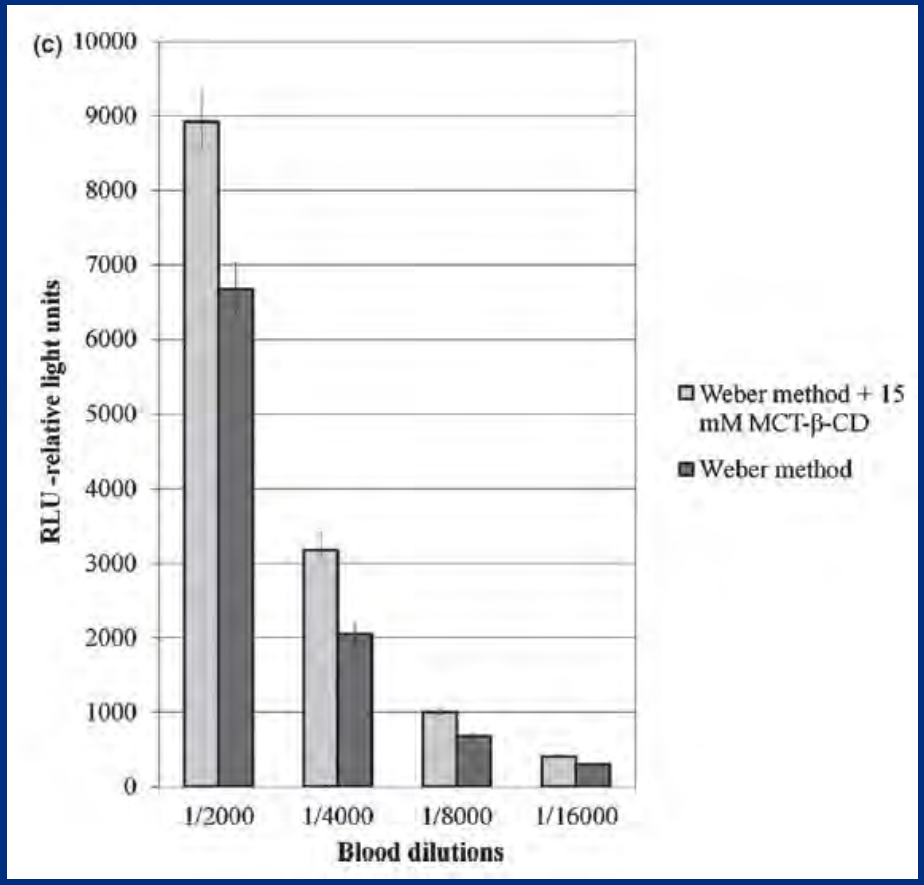
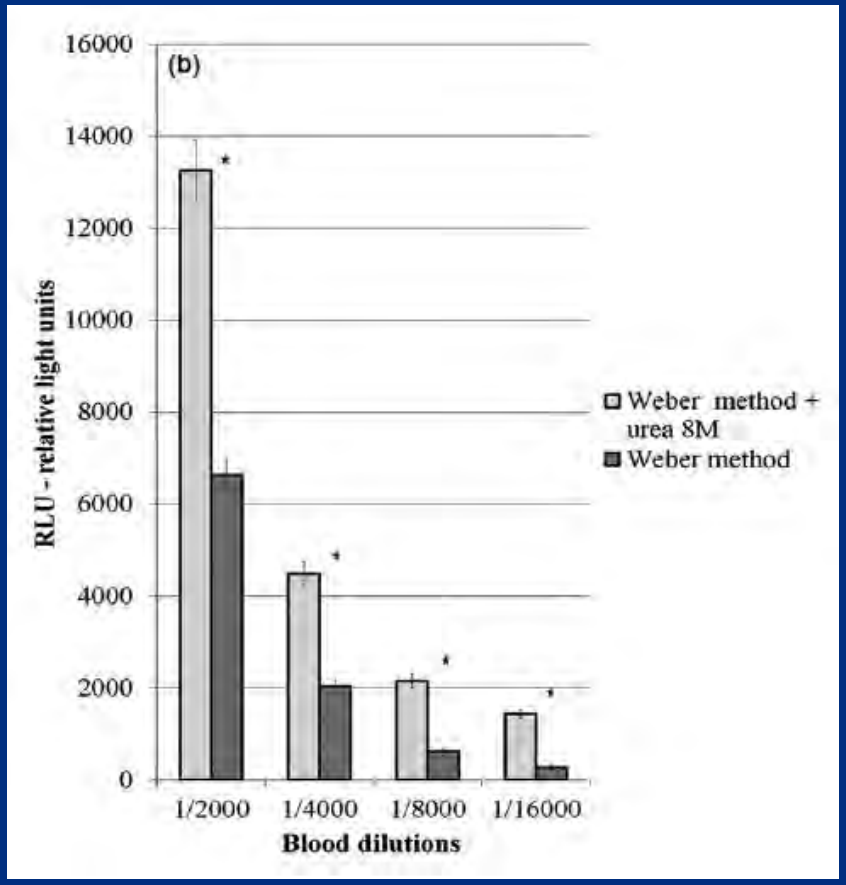


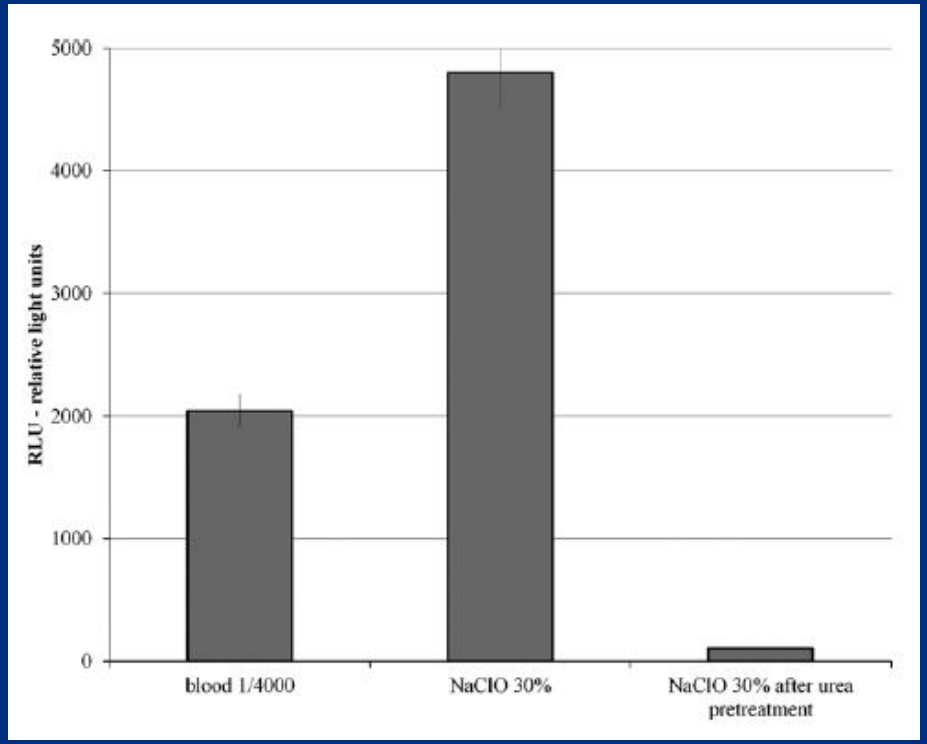
- Under alkaline conditions, luminol will undergo an oxidation process that opens the nitrogen containing ring and emits energy in the form of light at 425 nm (blue).
- Part I of this work looked at the addition of urea and its effect on denaturing hemoglobin.
- Part II studied the impact of adding β-type cyclodextrins to determine which specific one would enhance the intensity and duration of the chemiluminescent react the most.


(c)
RLU -relative light units
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1/2000
1/4000
1/8000
1/16000
Blood dilutions
Weber method + 15 mM MCT-β-CD
Weber method


(b)
RLU - relative light units
16000
14000
12000
10000
8000
6000
4000
2000
0
1/2000
1/4000
1/8000
1/16000
Blood dilutions
Weber method + urea 8M
Weber method

Results

- Monochloro-triazinyl-β-cyclodextrin at a concentration of 15 mM worked best.
- Pretreatment of bloodstains on Whatman pure cellulose discs (5 mm diameter) with 20 uL of 8 M urea 20 minutes prior to luminol treatment increased intensity.
- This treatment also had a positive effect on blood stains pretreated with 30% hypochlorite.



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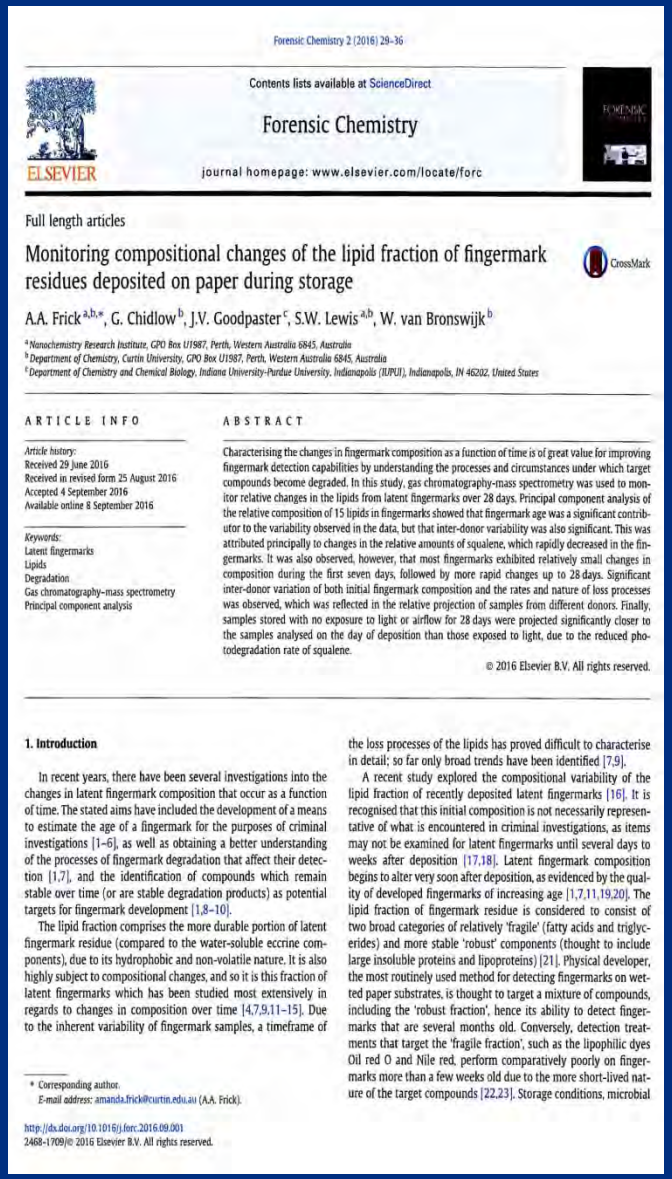
Introduction

- Frick et al. Monitoring Compositional Changes of the Lipid Fraction of Fingermark Residues Deposited on Paper During Storage. Forensic Chem 2016;2:29-36.
- The goal of this work was to monitor the change in lipid composition (15 lipids) of a latent print over a 28 day period.
- Samples analyzed 2, 5, 7, 9, 12, 14, 16, 19, 21, 23, 26, and 28 days after being deposited.



Forensic Chemistry 2 (2016) 29–36

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Full length articles

Monitoring compositional changes of the lipid fraction of fingermark residues deposited on paper during storage

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Latent fingermarks
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ABSTRACT

Characterising the changes in fingermark composition as a function of time is of great value for improving fingermark detection capabilities by understanding the processes and circumstances under which target compounds become degraded. In this study, gas chromatography-mass spectrometry was used to monitor relative changes in the lipids from latent fingermarks over 28 days. Principal component analysis of the relative composition of 15 lipids in fingermarks showed that fingermark age was a significant contributor to the variability observed in the data, but that inter-donor variability was also significant. This was attributed principally to changes in the relative amounts of squalene, which rapidly decreased in the fingermarks. It was also observed, however, that most fingermarks exhibited relatively small changes in composition during the first seven days, followed by more rapid changes up to 28 days. Significant inter-donor variation of both initial fingermark composition and the rates and nature of loss processes was observed, which was reflected in the relative projection of samples from different donors. Finally, samples stored with no exposure to light or airflow for 28 days were projected significantly closer to the samples analysed on the day of deposition than those exposed to light, due to the reduced photodegradation rate of squalene.

1. Introduction

In recent years, there have been several investigations into the changes in latent fingermark composition that occur as a function of time. The stated aims have included the development of a means to estimate the age of a fingermark for the purposes of criminal investigations [1–6], as well as obtaining a better understanding of the processes of fingermark degradation that affect their detection [1,7], and the identification of compounds which remain stable over time (or are stable degradation products) as potential targets for fingermark development [1,8–10].

The lipid fraction comprises the more durable portion of latent fingermark residue (compared to the water-soluble eccrine components), due to its hydrophobic and non-volatile nature. It is also highly subject to compositional changes, and so it is this fraction of latent fingermarks which has been studied most extensively in regards to changes in composition over time [4,7,9,11–15]. Due to the inherent variability of fingermark samples, a timeframe of the loss processes of the lipids has proved difficult to characterise in detail; so far only broad trends have been identified [7,9].

A recent study explored the compositional variability of the lipid fraction of recently deposited latent fingermarks [16]. It is recognised that this initial composition is not necessarily representative of what is encountered in criminal investigations, as items may not be examined for latent fingermarks until several days to weeks after deposition [17,18]. Latent fingermark composition begins to alter very soon after deposition, as evidenced by the quality of developed fingermarks of increasing age [1,7,11,19,20]. The lipid fraction of fingermark residue is considered to consist of two broad categories of relatively 'fragile' (fatty acids and triglycerides) and more stable 'robust' components (thought to include large insoluble proteins and lipoproteins) [21]. Physical developer, the most routinely used method for detecting fingermarks on wetted paper substrates, is thought to target a mixture of compounds, including the 'robust fraction', hence its ability to detect fingermarks that are several months old. Conversely, detection treatments that target the 'fragile fraction', such as the lipophilic dyes Oil red O and Nile red, perform comparatively poorly on fingermarks more than a few weeks old due to the more short-lived nature of the target compounds [22,23]. Storage conditions, microbial

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2468-1709/

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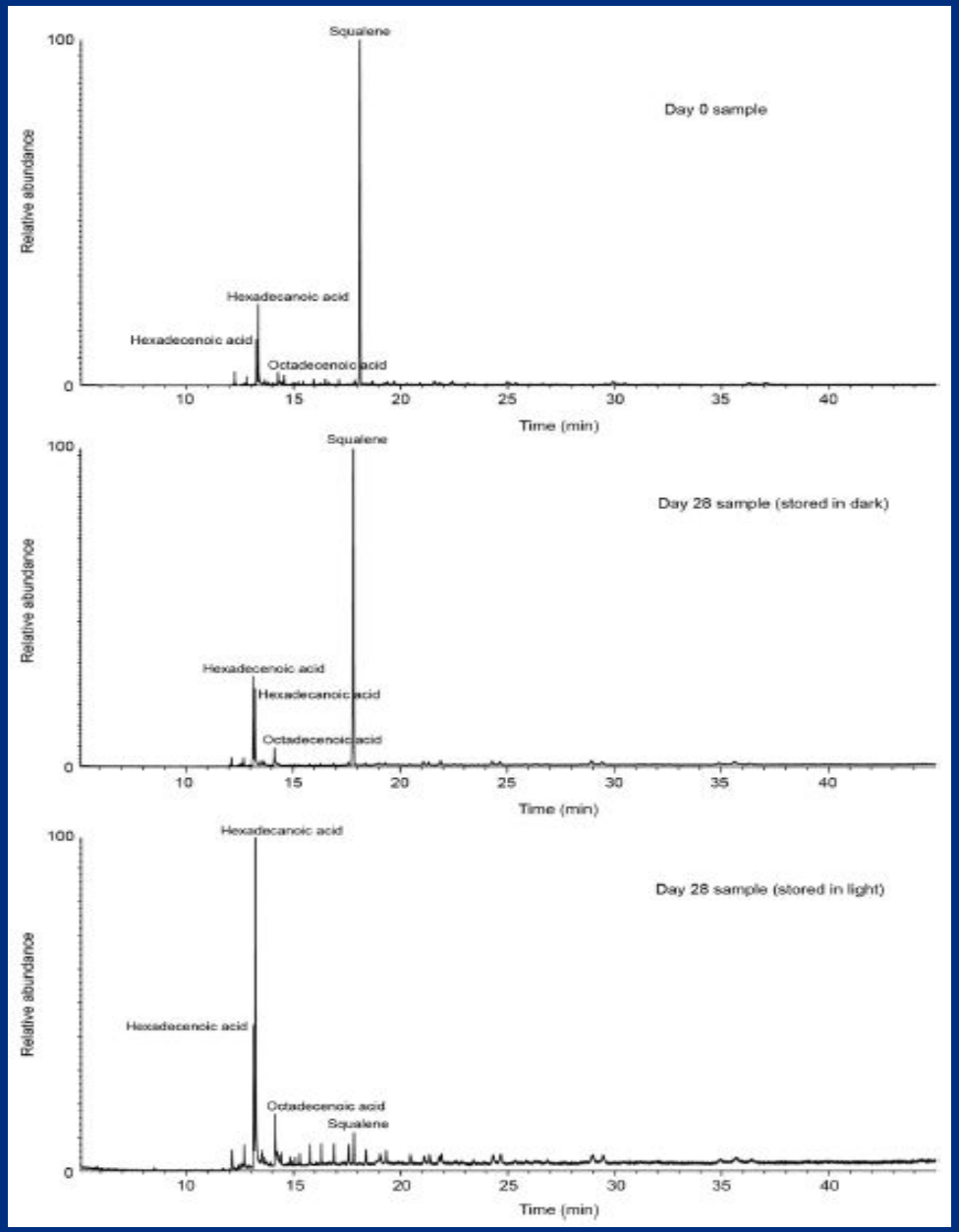
Results

- Fingerprints exhibited only small changes during the first seven days; more rapid changes were observed up to 28 days.
- Significant inter-donor variation (8 donors) was present in both initial latent print composition and rates/nature of lipid loss.
- Squalene diminished rapidly; still found after 28 days in 7/8 donors; accelerated loss in light; photo-oxidative degradation.
- Proportion of peak areas of saturated WE/monounsaturated WE increases.
- Using lipid degradation is problematic for LP age estimations – especially where storage conditions are not accurately known.



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Introduction

- Szkuta B et al. DNA Contamination of Fingerprint Brushes. Forensic Sci Int 2017;277:41-50.
- The goal of this project was to evaluate the risk of contamination through transfer of dried saliva and skin deposits from and to glass surfaces with new and used squirrel and fiberglass brushes.
- 1% hypochlorite and 5% Virkon solutions were assessed for their abilities to eradicate DNA from the brushes.

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DNA decontamination of fingerprint brushes

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ABSTRACT

Genetic profiling of DNA collected from fingerprints that have been exposed to various enhancement techniques is routine in many forensic laboratories. As a result of direct contact with fingermark residues during treatment, there is concern around the DNA contamination risk of dusting fingermarks with fingerprint brushes. Previous studies have demonstrated the potential for cross-contamination between evidentiary items through various mechanisms, highlighting the risk of using the same fingerprint brush to powder multiple surfaces within and between crime-scenes.

Experiments were performed to assess the contamination risk of reused fingerprint brushes through the transfer of dried saliva and skin deposits from and to glass surfaces with new unused squirrel hair and fiberglass brushes. Additional new unused brushes and brushes previously used in casework were also tested for their ability to contaminate samples. In addition, the ability to eradicate DNA from used squirrel hair and fiberglass fingerprint brushes was assessed using a 1% sodium hypochlorite solution and a 5% solution of a commercially available alternative, Virkon. DNA profiling results from surfaces contacted by treated and untreated brushes were compared to determine the effectiveness of the devised cleaning protocol. Brush durability was also assessed over multiple wash/rinse/dry cycles with both agents.

Varying amounts of DNA-containing material were collected and transferred by squirrel hair and fiberglass brushes, with detectability on the secondary surface dependent on the biological nature of the material being transferred. The impact of DNA contamination from dirty fingerprint brushes was most apparent in simulations involving the transfer of dried saliva and brushes previously used in casework, while minimal transfer of touch DNA was observed. Alarmingly, large quantities of DNA were found to reside on new unused squirrel hair brushes, while no DNA was detected on new unused fiberglass brushes or brushes sold as DNA-free.

Squirrel hair brushes were easily and effectively cleaned with both hypochlorite and Virkon, with no evidence of DNA transfer between exhibits by treated brushes. Brushes were still deemed useable after multiple cleaning cycles with either agent. In contrast, fiberglass bristles became tangled and matted when wet and could not be cleaned effectively using either method. It is recommended they are disposed of following use. Each laboratory should consider their current circumstances before adapting a cleaning method. The implementation of a program to monitor the effectiveness of the cleaning regime is also advised.

1. Introduction

Fingerprints and DNA are both valuable sources of forensic evidence. Today, the ability to generate DNA profiles from touched objects [1–4], resulting from the increased sensitivity of DNA typing methodologies, has enabled the routine collection of DNA from fingerprints. In cases where conventional fingerprint analysis is uninformative due to smeared or partial prints, DNA analysis provides an alternative means for obtaining probative evidence about the offender. In some laboratories, the collection of DNA from evidentiary items occurs prior to latent print processing, while in others collection occurs following exposure to various optical, physical and chemical fingerprint enhancement methods [5–7]. Considering the latter, there is concern around the DNA contamination risk associated with various enhancement methods as a result of direct contact with fingermark residues during treatment [8–10].

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0379-0738/

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Results

- Noticeable DNA transfer was apparent with dried saliva (primary surface) to a secondary surface containing a single hand deposit.
- Minimal transfer was observed via squirrel hair brushes following contact with hand prints (single/multiple) on glass.
- Transfers increased when brushes were artificially contaminated through direct contact (simulated used/casework brushes).
- In some cases the majority of the DNA recovered (65%) was from unknown sources (potential for incorrect linking of crime scene DNA).
- Bristles of new/unused squirrel hair brushes contained large quantities of DNA (necessitates cleaning brushes before use – including the bristles, handle, and any packaging/tube holding the brush).

Results

- Using hypochlorite (1%) or Virkon (5%) significantly reduced DNA on squirrel hair brushes.
- The transfer of unique alleles from a donor's saliva decreased from 16 to 1 following treatment with both cleaning solutions.
- Other research has indicated that hypochlorite is better at eradicating heavy DNA deposits than Virkon.
- Fiberglass bristles became matted when treated and were unusable.
- Recommendation: Regular cleaning or replacement of fingerprint brushes is needed to prevent DNA contamination.
- Recommendation: Use fresh aliquots of powder between exhibits and scenes.

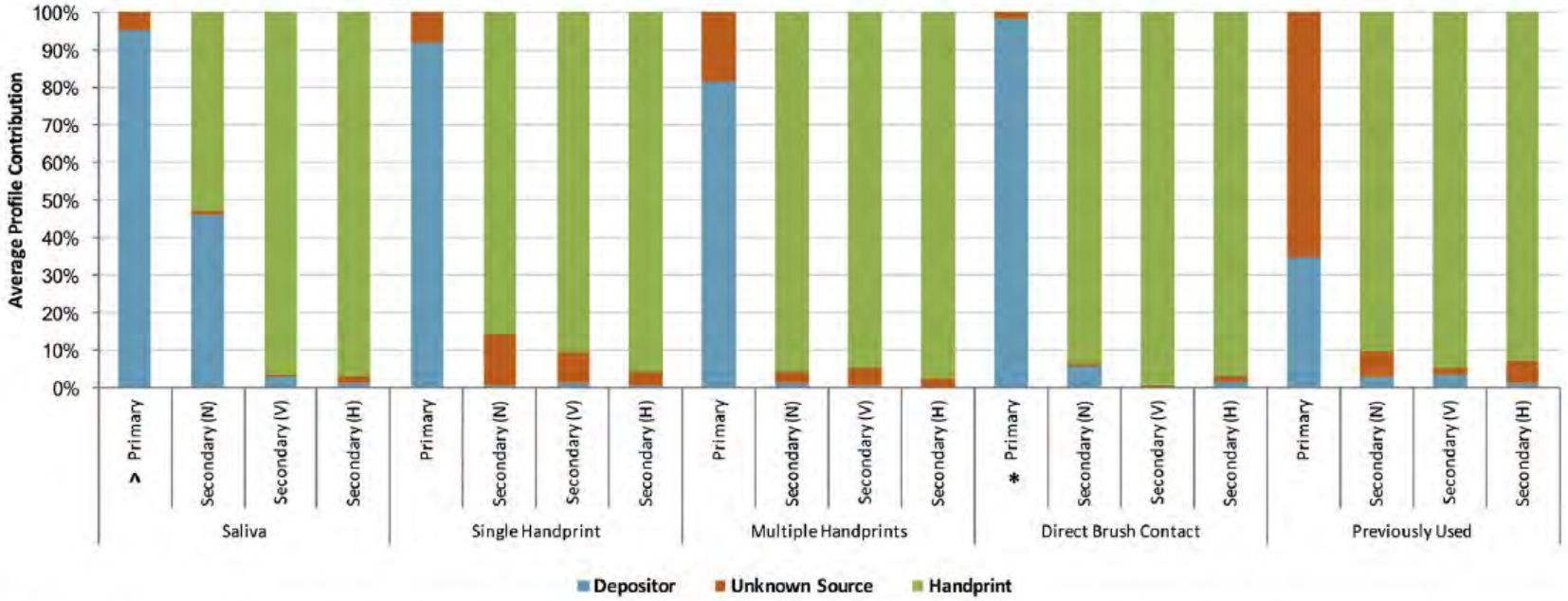


Fig. 3. Average DNA contributions (%) attributable to donors in the profiles generated from primary and secondary surfaces in simulations involving squirrel hair brushes. Unless indicated (*^), profiles were generated following the dusting of a primary surface deposited with biological material, followed by the subsequent dusting of a secondary surface containing a handprint with Virkon (V) or hypochlorite (H) treated brushes, or those that remained untreated (N).
^Profiles generated from cut bristles following dusting of the primary surface without powder.
*Profiles generated from swabs of untreated (none) bristles following dusting of the primary and secondary surfaces with powder.

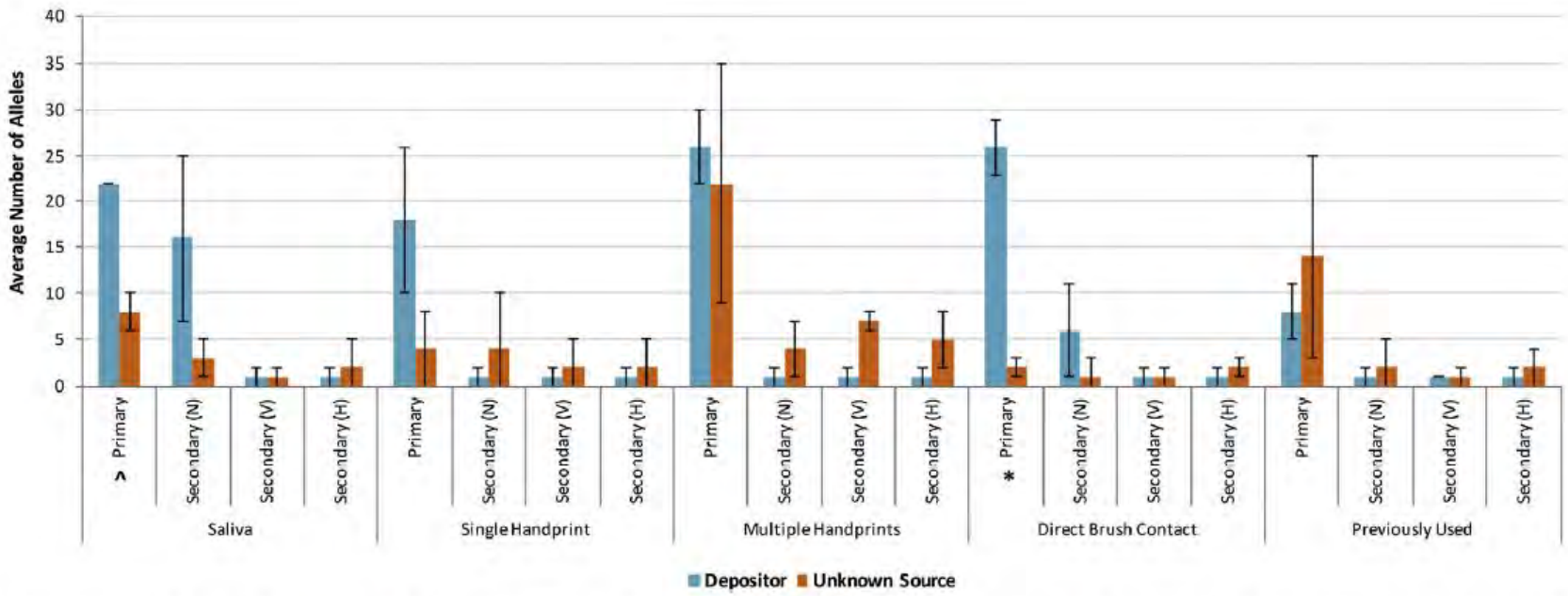


Fig. 4. Average number of alleles attributable to donors in the profiles generated from primary and secondary surfaces in simulations involving squirrel hair brushes. Unless indicated (*^), profiles were generated following the dusting of a primary surface deposited with biological material, followed by the subsequent dusting of a secondary surface containing a handprint with Virkon (V) or hypochlorite (H) treated brushes, or those that remained untreated (N).
^Profiles generated from cut bristles following dusting of the primary surface without powder.
*Profiles generated from swabs of untreated (none) bristles following dusting of the primary and secondary surfaces with powder.

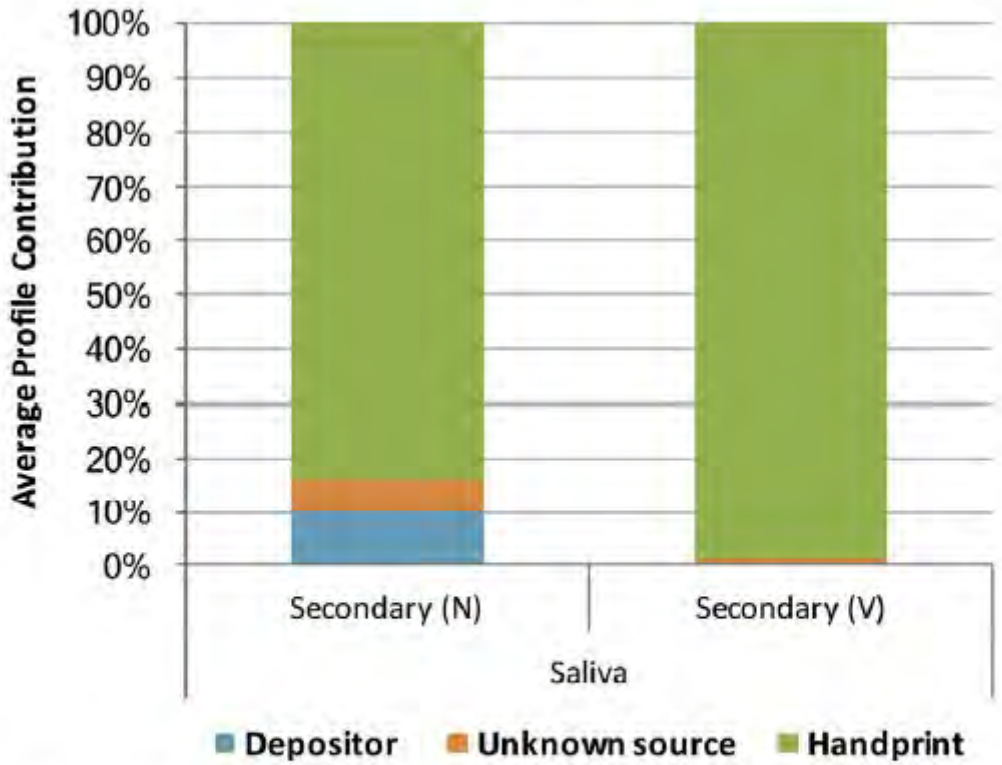
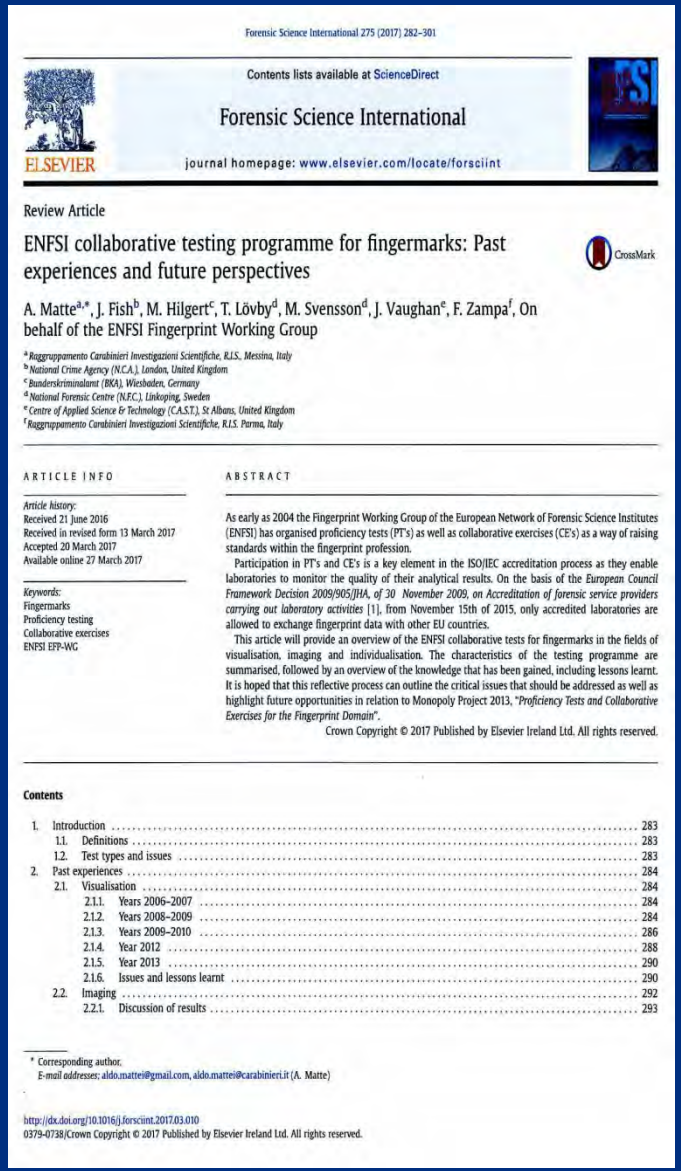


Fig. 5. Average DNA contributions (%) attributable to donors in the profiles generated from secondary surfaces in simulations involving fibreglass brushes. Profiles were generated following the dusting of a primary surface deposited with dried saliva, followed by the subsequent dusting of a secondary surface containing a handprint with Virkon (V) treated brushes, or those that remained untreated (N).

Introduction

- Mattei A, et al. ENFSI Collaborative Testing Programme for Fingermarks: Past Experiences and Future Perspectives. Forensic Sci Int 2017;275:282-301.
- This review paper gives a history of the ENFSI FPWG collaborative exercises from 2004-2016.
- Exercises were conducted for identification, development, and (later) image enhancement.



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Review Article

ENFSI collaborative testing programme for fingermarks: Past experiences and future perspectives

A. Matte[a,*], J. Fish[b], M. Hilgert[c], T. Lövby[d], M. Svensson[d], J. Vaughan[e], F. Zampa[f], On behalf of the ENFSI Fingerprint Working Group

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[b] National Crime Agency (N.C.A.), London, United Kingdom
[c] Bunderskriminalamt (BKA), Wiesbaden, Germany
[d] National Forensic Centre (N.F.C.), Linkoping, Sweden
[e] Centre of Applied Science & Technology (C.A.S.T.), St Albans, United Kingdom
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Collaborative exercises
ENFSI EFP-WG

ABSTRACT

As early as 2004 the Fingerprint Working Group of the European Network of Forensic Science Institutes (ENFSI) has organised proficiency tests (PT's) as well as collaborative exercises (CE's) as a way of raising standards within the fingerprint profession.

Participation in PT's and CE's is a key element in the ISO/IEC accreditation process as they enable laboratories to monitor the quality of their analytical results. On the basis of the *European Council Framework Decision 2009/905/JHA, of 30 November 2009, on Accreditation of forensic service providers carrying out laboratory activities* [1], from November 15th of 2015, only accredited laboratories are allowed to exchange fingerprint data with other EU countries.

This article will provide an overview of the ENFSI collaborative tests for fingermarks in the fields of visualisation, imaging and individualisation. The characteristics of the testing programme are summarised, followed by an overview of the knowledge that has been gained, including lessons learnt. It is hoped that this reflective process can outline the critical issues that should be addressed as well as highlight future opportunities in relation to Monopoly Project 2013, "*Proficiency Tests and Collaborative Exercises for the Fingerprint Domain*".

Contents

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0379-0738/

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Overview

- In 2004 the ENFSI FPWG initiated a development/identification collaborative test.
- Visualization test issues: how to guarantee same prints deposited on all samples; sweat simulations not validated; transportation of samples to labs – different environmental conditions possible.
- Imaging test issues: use real prints or digitally modified images; what kind of performance criteria should be used for evaluation.
- Identification test issues: content must be equivalent to normal casework; include prints of no value; difficulty in defining an objective scale; common scale of conclusions needed; blind tests to minimize bias (i.e., that the examiner is aware of being tested).

Results

- This summary focused on the 2012/2014 tests.
- Christmas wrapping paper was the substrate and there were 36 participants; six total prints deposited (4 on NP and 2 on porous).
- Each organization tried between 2-7 processes to visualize prints.
- VMD and PD found incompatible; DFO/IND best on M6 (not PD).
- Imaging test was from 2014; images distributed in .jpeg format – not optimal (but it made it easier to distribute via e-mail); no control.
- ID test organized by Swiss Federal Police/NFI; 14 prints/4 potential donors; 0.4% false positive rate; 1% false negative rate.

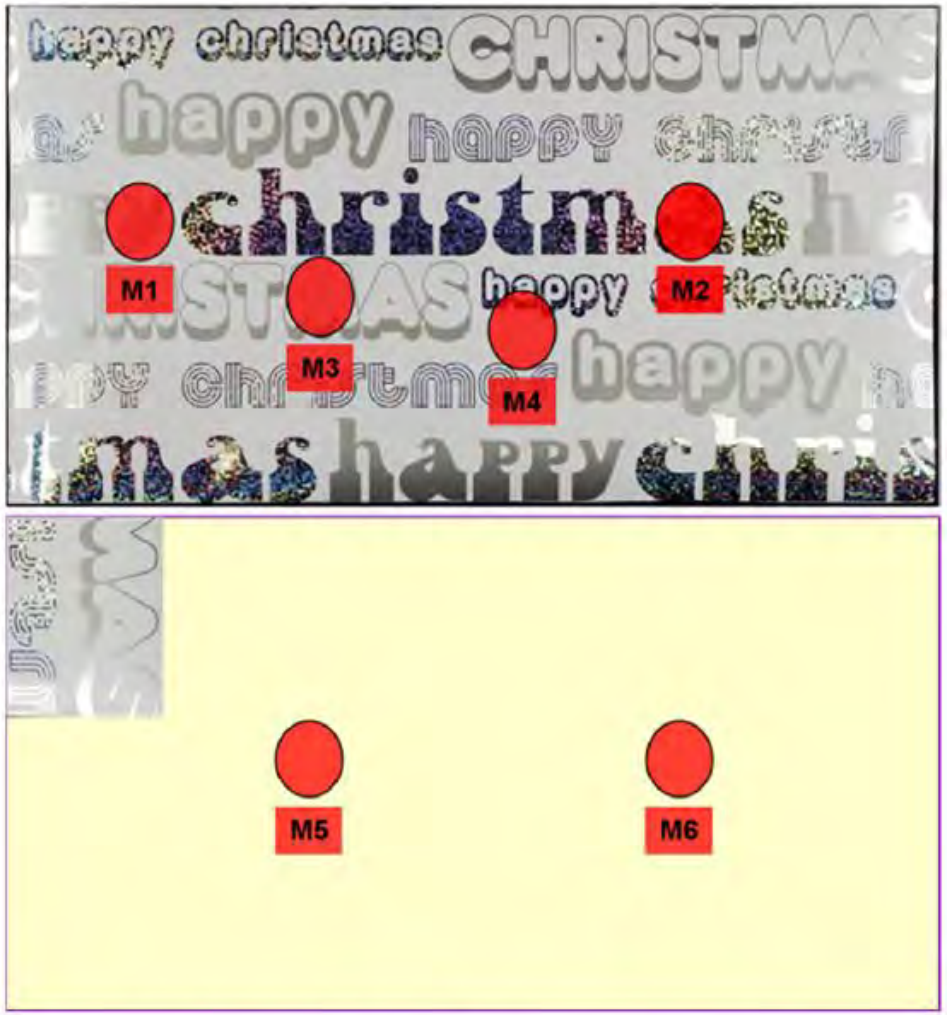
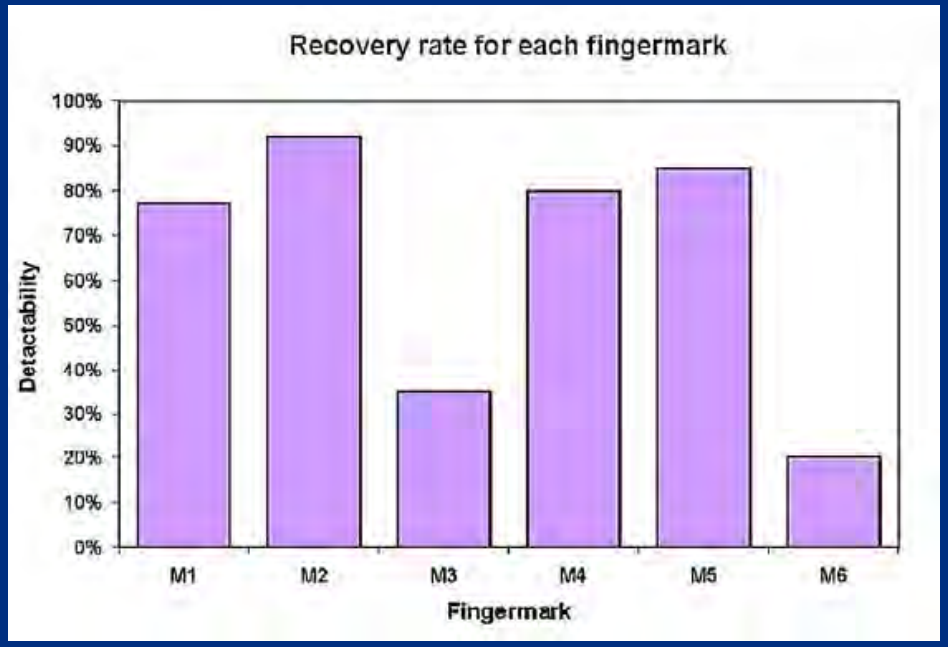
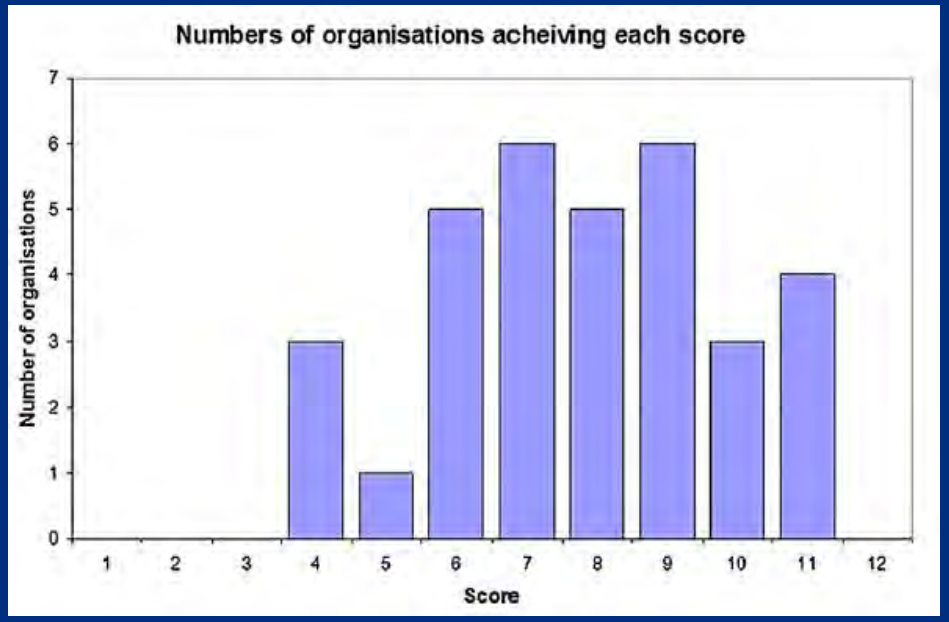


Fig. 9. Visualisation test 2012: marks present on the item.





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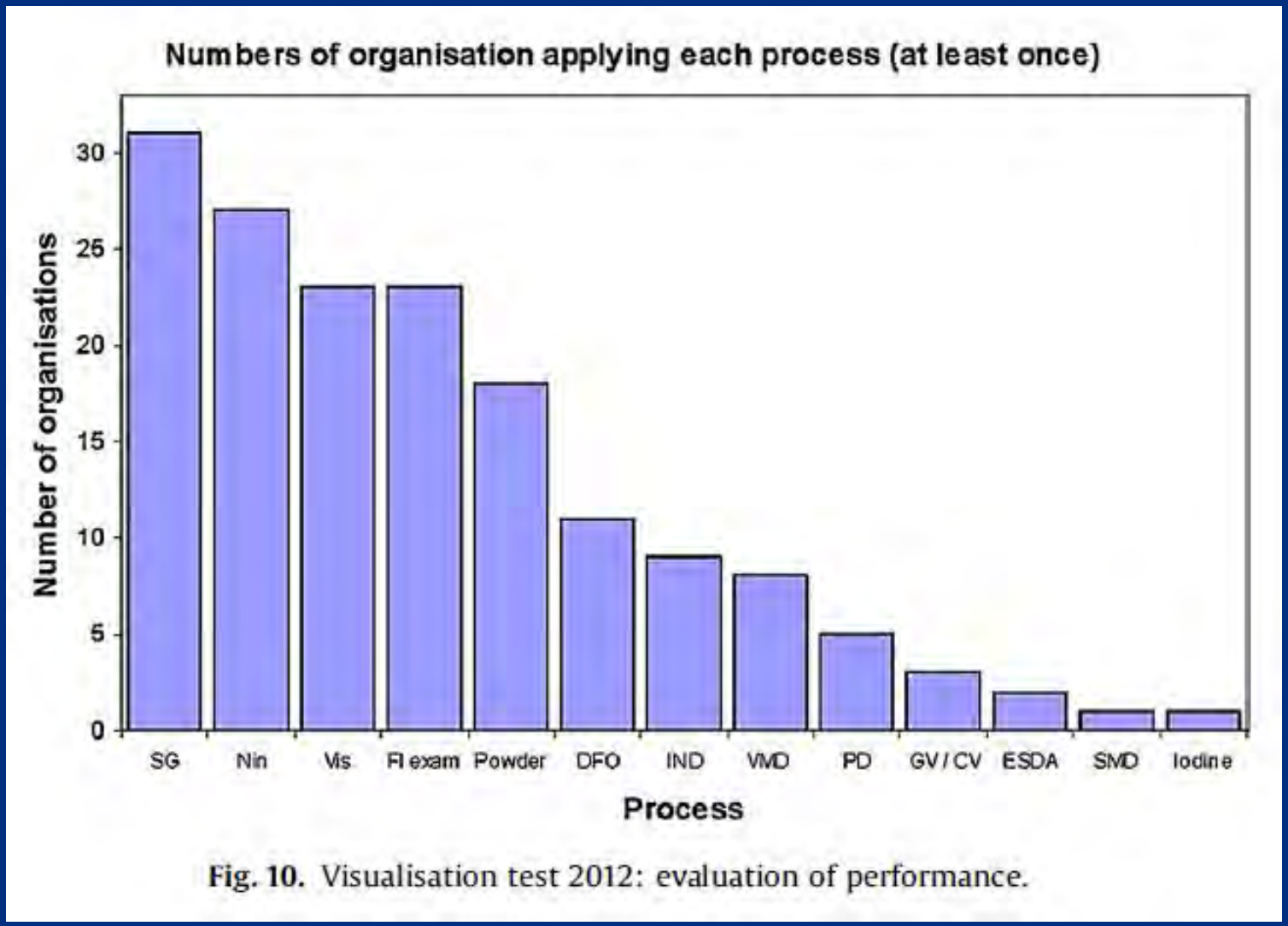
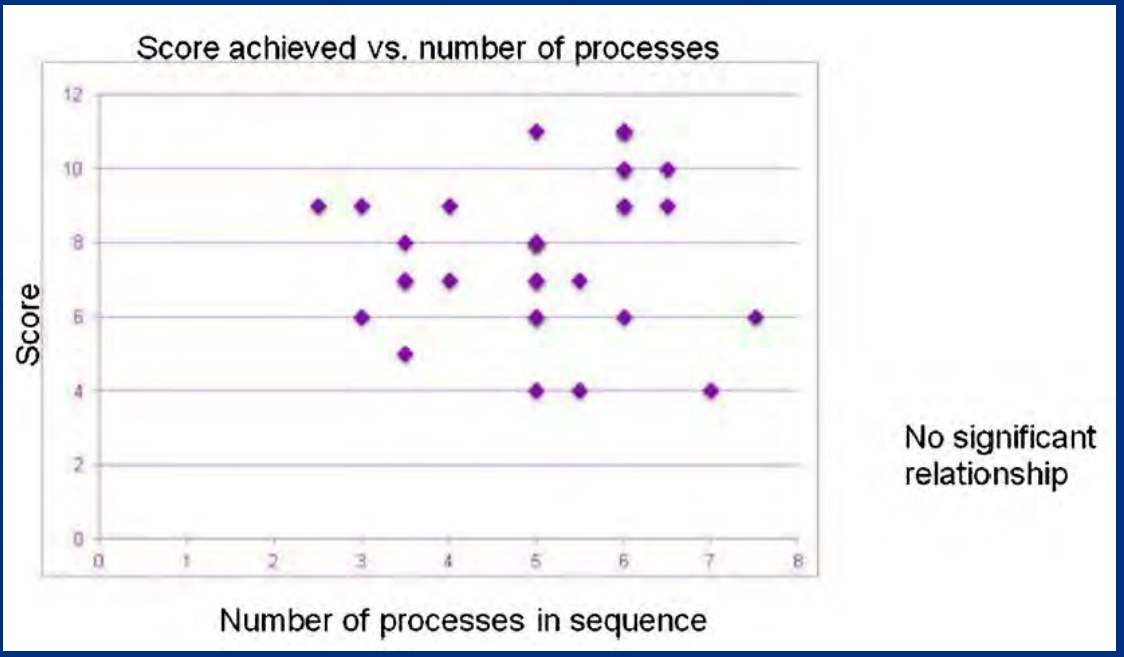
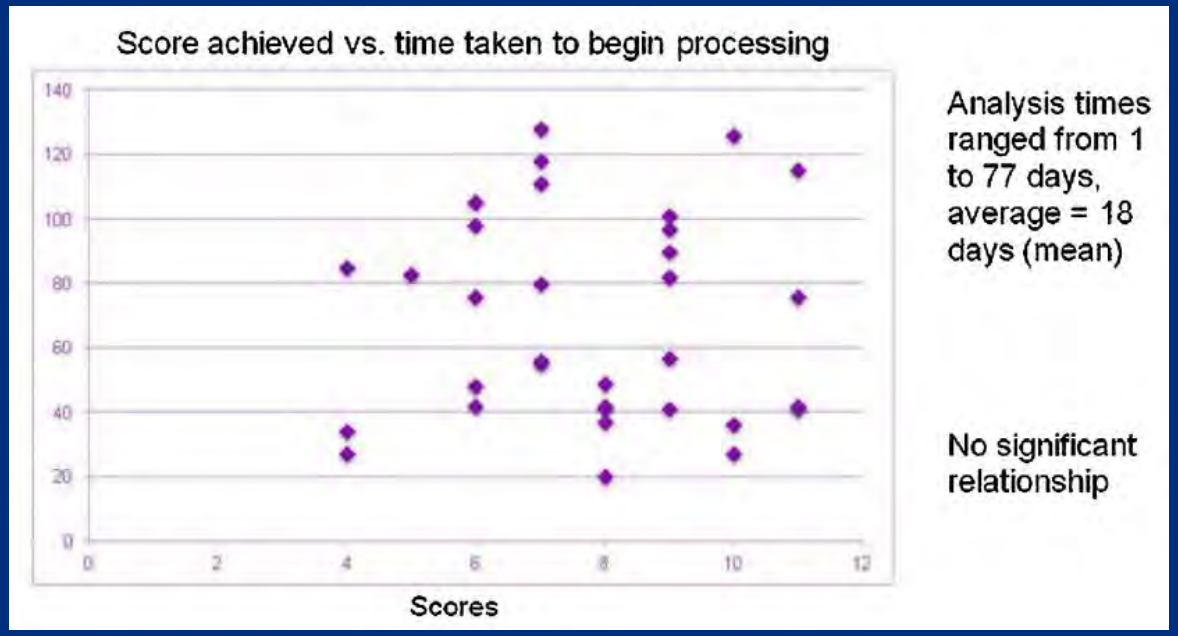


Fig. 10. Visualisation test 2012: evaluation of performance.



No significant relationship



Analysis times ranged from 1 to 77 days, average = 18 days (mean)

No significant relationship

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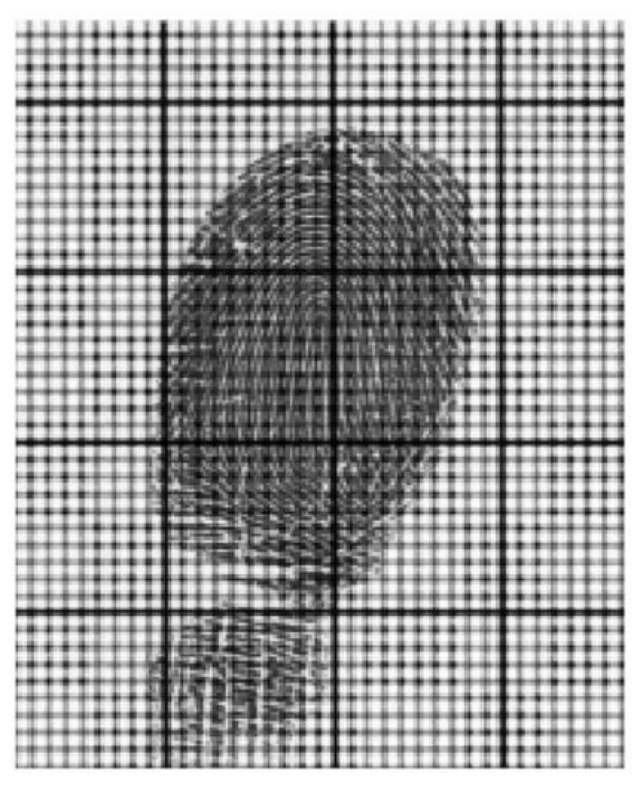

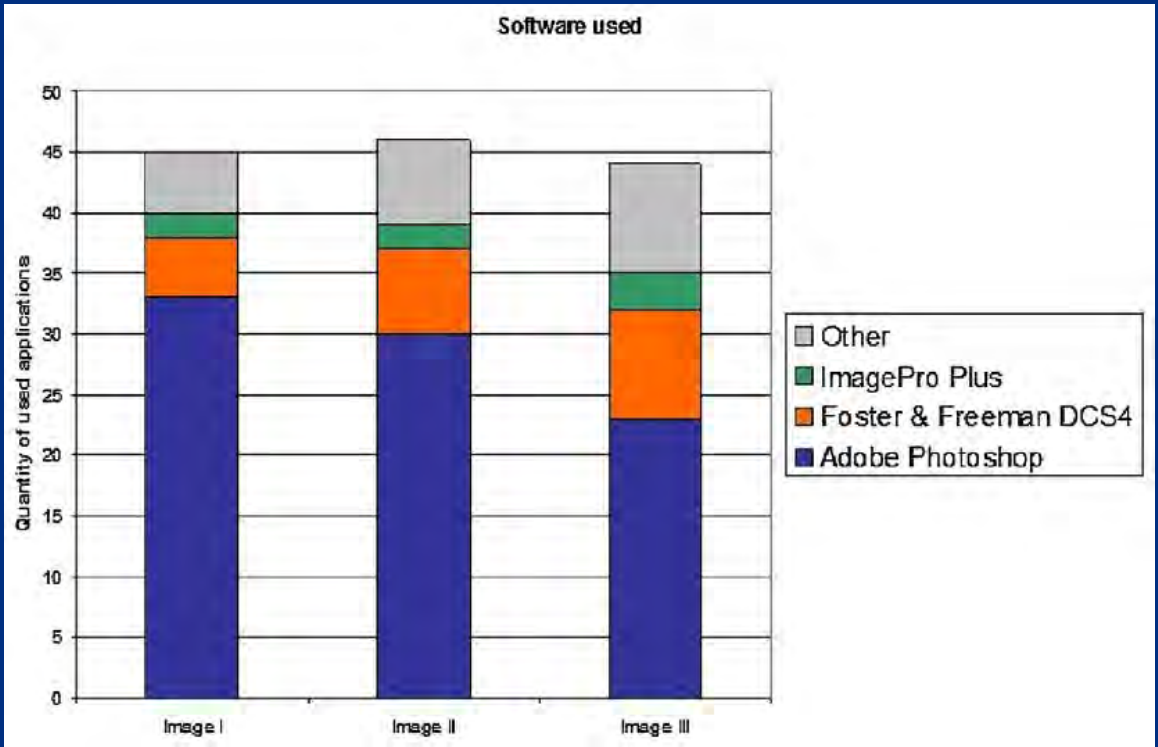

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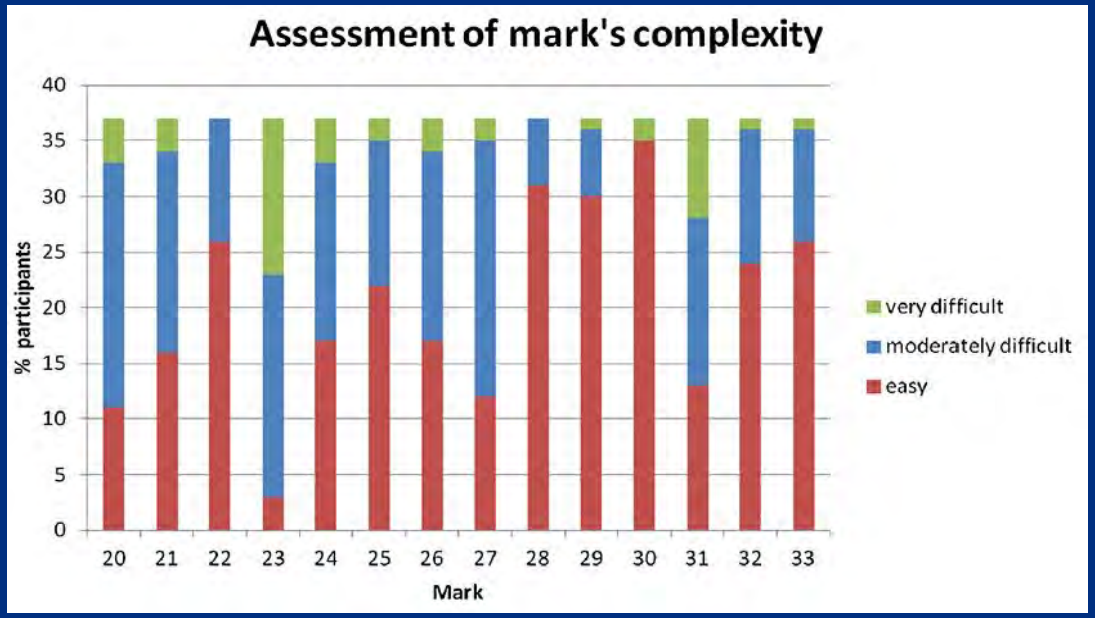

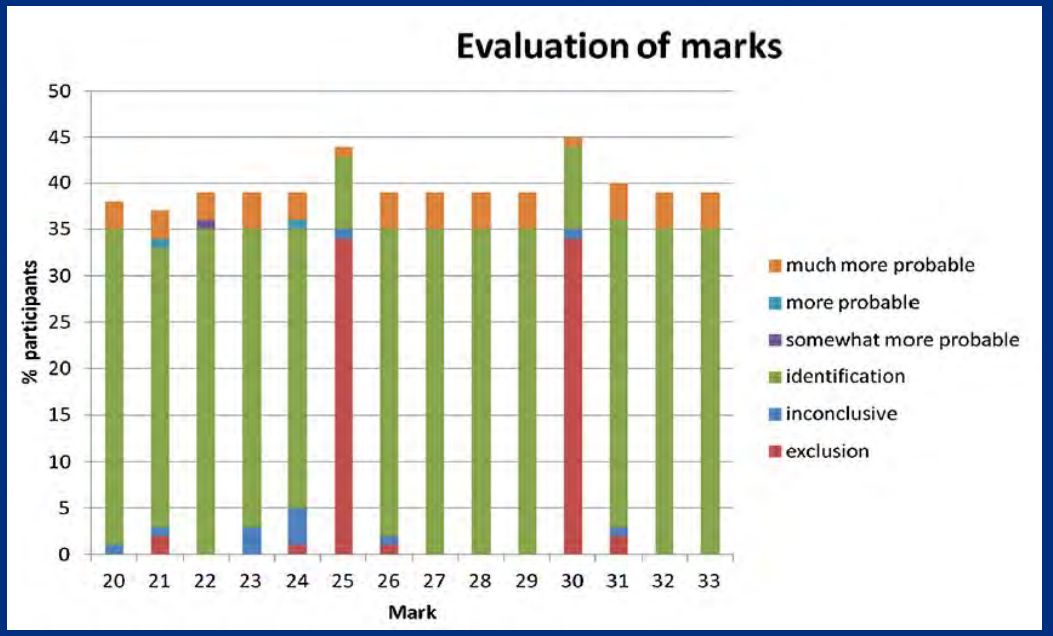

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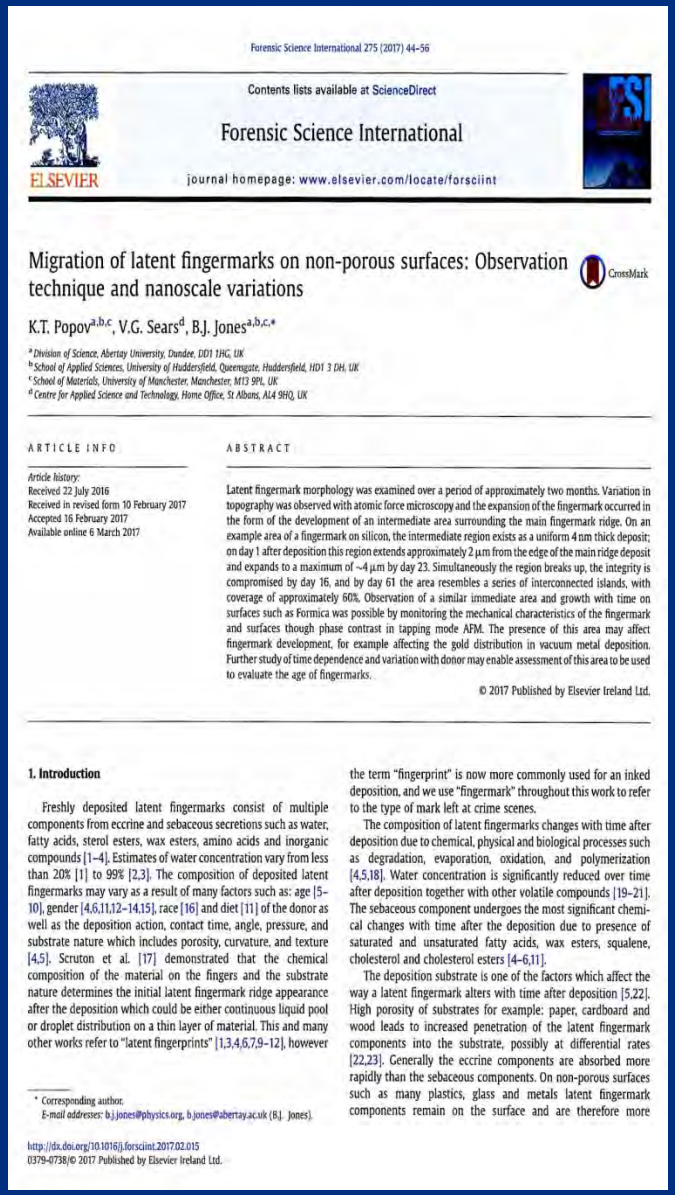
	Total	Percentage
Number of marks which have been identified or excluded "correctly"	471	90.9%
Number of marks which have been compared or excluded "correctly" but the evaluation was "inconclusive" based on the applied standard	10	1.9%
Number of marks which have "wrongly" excluded	5	1.0%
Number of marks which have "wrongly" identified ("correct" person, "wrong" finger)	2	0.4%
Number of marks with incomplete or contradictory results	30	5.8%

	Test 2004		Test 2010		Test 2012	
	Total	**Percentage**	**Total**	**Percentage**	**Total**	**Percentage**
False Positives	8	5.9% (8/135)	0	0%	2	0.4% (2/534)
False Negatives	25	18.5% (25/135)	14	3.2% (14/435)	5	1% (5/522)

Fig. 26. Individualisation tests 2004–2010–2012: false positives and false negatives rates.

Introduction

- Popov KT, Sears VG, Jones BJ. Migration of Latent Fingermarks on Non-porous Surfaces: Observation Technique and Nanoscale Variations. Forensic Sci Int 2017;275:44-56.
- The goal of this effort was to study latent print topography and how it varies over time using atomic force microscopy (AFM).



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Migration of latent fingermarks on non-porous surfaces: Observation technique and nanoscale variations

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ABSTRACT

Latent fingermark morphology was examined over a period of approximately two months. Variation in topography was observed with atomic force microscopy and the expansion of the fingermark occurred in the form of the development of an intermediate area surrounding the main fingermark ridge. On an example area of a fingermark on silicon, the intermediate region exists as a uniform 4 nm thick deposit; on day 1 after deposition this region extends approximately 2 μm from the edge of the main ridge deposit and expands to a maximum of ~4 μm by day 23. Simultaneously the region breaks up, the integrity is compromised by day 16, and by day 61 the area resembles a series of interconnected islands, with coverage of approximately 60%. Observation of a similar immediate area and growth with time on surfaces such as Formica was possible by monitoring the mechanical characteristics of the fingermark and surfaces though phase contrast in tapping mode AFM. The presence of this area may affect fingermark development, for example affecting the gold distribution in vacuum metal deposition. Further study of time dependence and variation with donor may enable assessment of this area to be used to evaluate the age of fingermarks.

1. Introduction

Freshly deposited latent fingermarks consist of multiple components from eccrine and sebaceous secretions such as water, fatty acids, sterol esters, wax esters, amino acids and inorganic compounds [1–4]. Estimates of water concentration vary from less than 20% [1] to 99% [2,3]. The composition of deposited latent fingermarks may vary as a result of many factors such as: age [5–10], gender [4,6,11,12–14,15], race [16] and diet [11] of the donor as well as the deposition action, contact time, angle, pressure, and substrate nature which includes porosity, curvature, and texture [4,5]. Scruton et al. [17] demonstrated that the chemical composition of the material on the fingers and the substrate nature determines the initial latent fingermark ridge appearance after the deposition which could be either continuous liquid pool or droplet distribution on a thin layer of material. This and many other works refer to "latent fingerprints" [1,3,4,6,7,9–12], however the term "fingerprint" is now more commonly used for an inked deposition, and we use "fingermark" throughout this work to refer to the type of mark left at crime scenes.

The composition of latent fingermarks changes with time after deposition due to chemical, physical and biological processes such as degradation, evaporation, oxidation, and polymerization [4,5,18]. Water concentration is significantly reduced over time after deposition together with other volatile compounds [19–21]. The sebaceous component undergoes the most significant chemical changes with time after the deposition due to presence of saturated and unsaturated fatty acids, wax esters, squalene, cholesterol and cholesterol esters [4–6,11].

The deposition substrate is one of the factors which affect the way a latent fingermark alters with time after deposition [5,22]. High porosity of substrates for example: paper, cardboard and wood leads to increased penetration of the latent fingermark components into the substrate, possibly at differential rates [22,23]. Generally the eccrine components are absorbed more rapidly than the sebaceous components. On non-porous surfaces such as many plastics, glass and metals latent fingermark components remain on the surface and are therefore more

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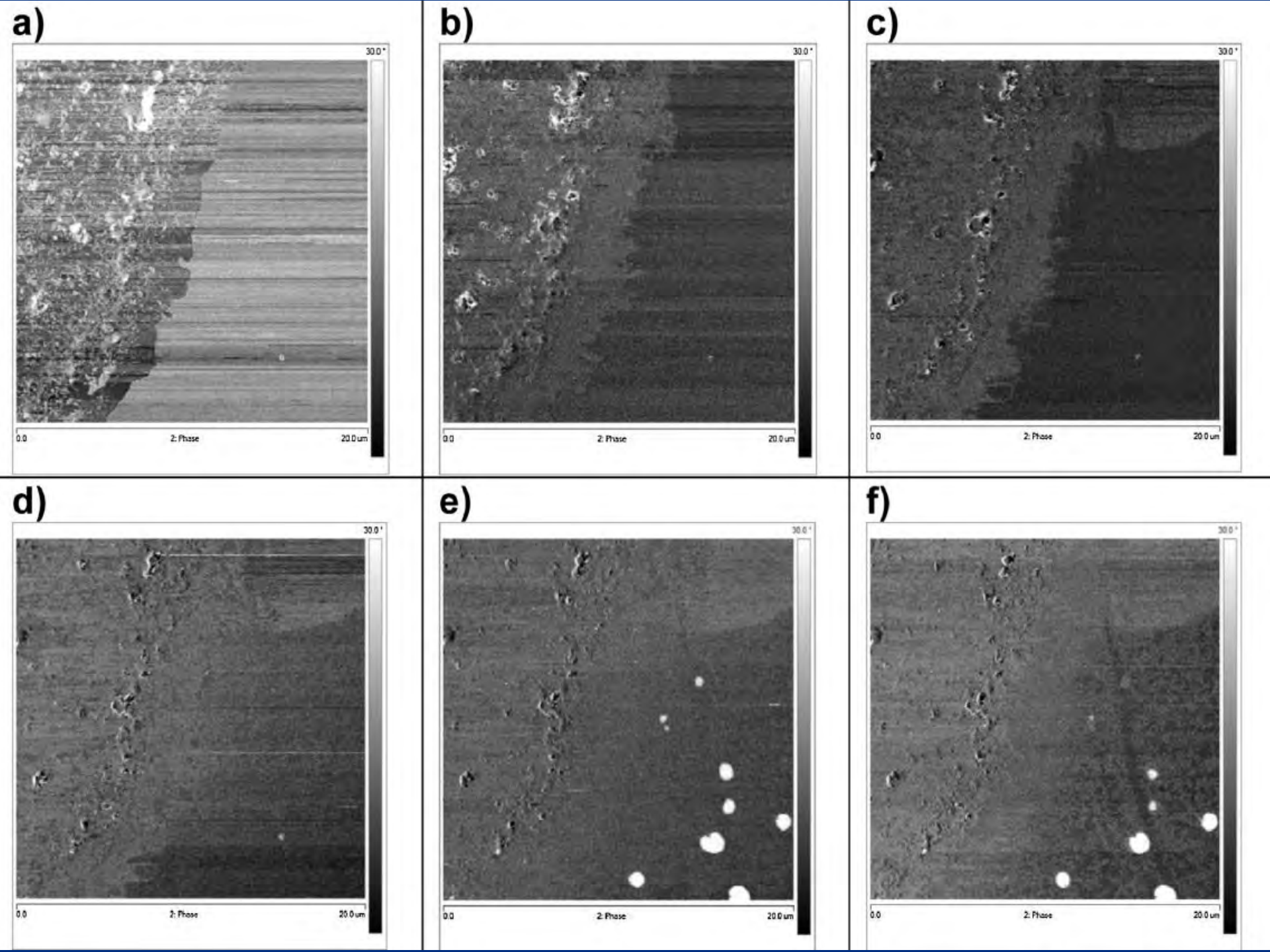
Overview

- Natural prints were deposited on a polished silicon or Formica wafers by 8 donors.
- Samples were stored in the ambient environment (variable %RH; 20-25°C) for up to 2 months (exposed to periodic light).
- Measurements were taken for the silicon wafers at the following intervals: 1, 8, 16, 23, 30, 44, and 61 days.
- Measurements were taken for the Formica wafers at the following intervals: 1, 8, 16, 21, 44, and 69 days.
- The use of fingerprint ridge spreading as a means of establishing a age/timeline of a deposit is unlikely to be accurate/reproducible.


a)
b)
c)
d)
e)
f)
30.0 °
0.0
2: Phase
20.0 um

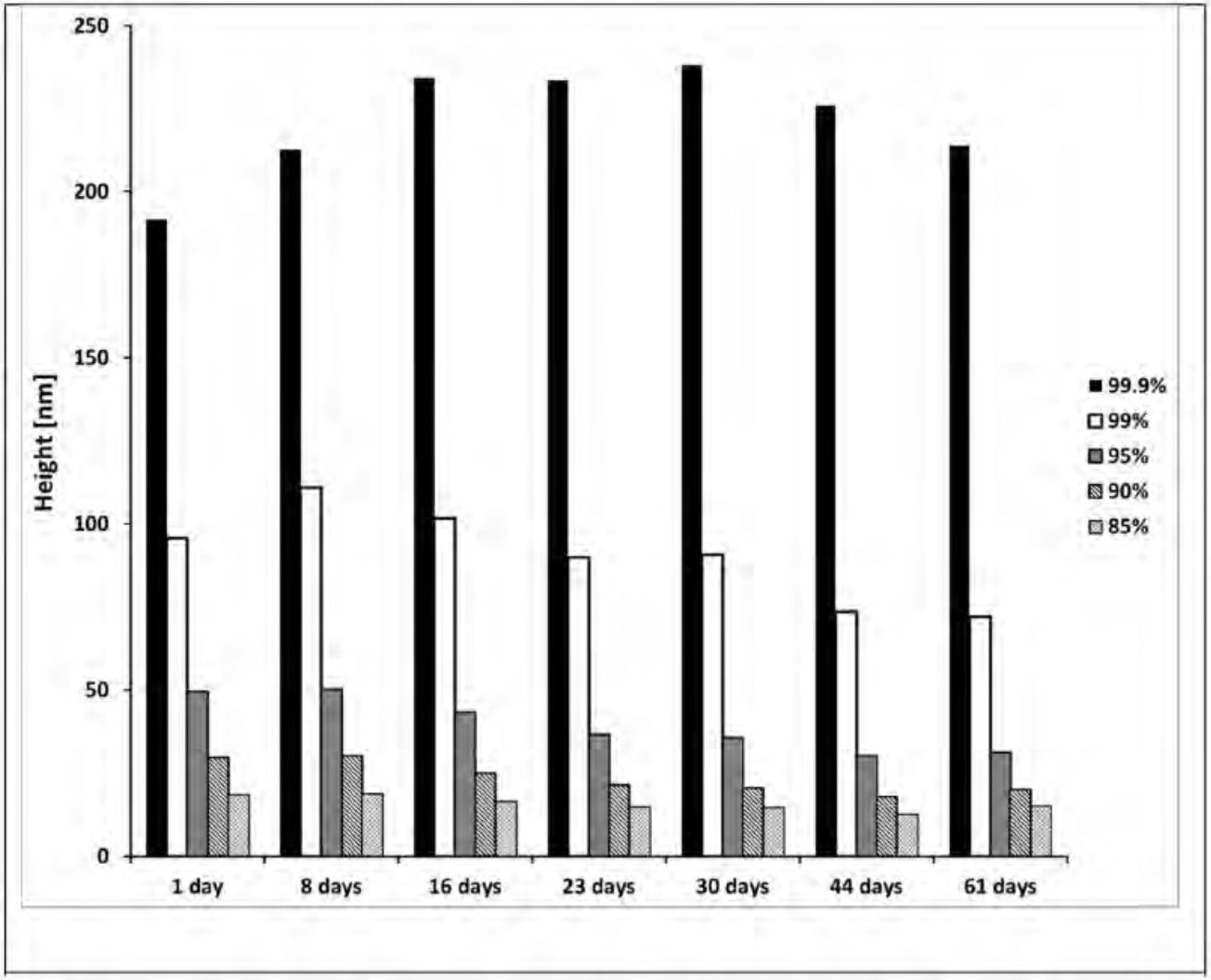


Fig. 4. Height changes with time at 20 × 20 μm scan size of latent fingermark on polished silicon wafer based on the bearing analysis.

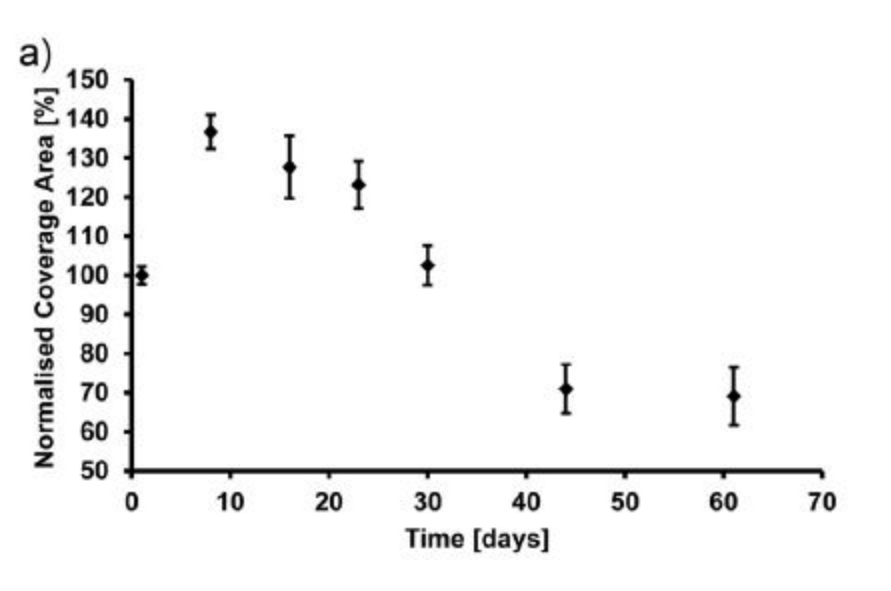
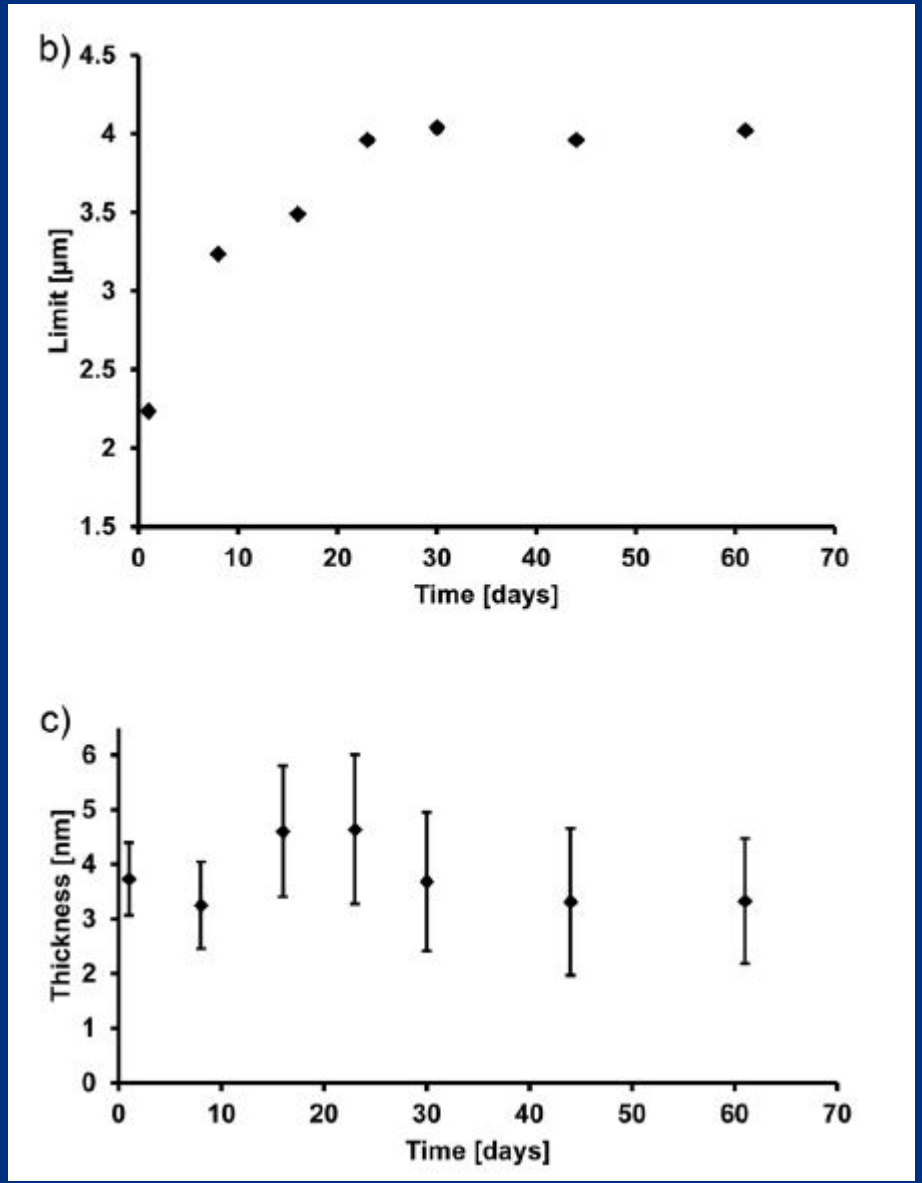


Fig. 7. (a) Normalised intermediate area coverage [%] from the 25 μm^2 scanned area ($5 \times 5\,\mu m$), (b) Intermediate area limit [μm] by section and (c) Intermediate area thickness and uniformity [nm].

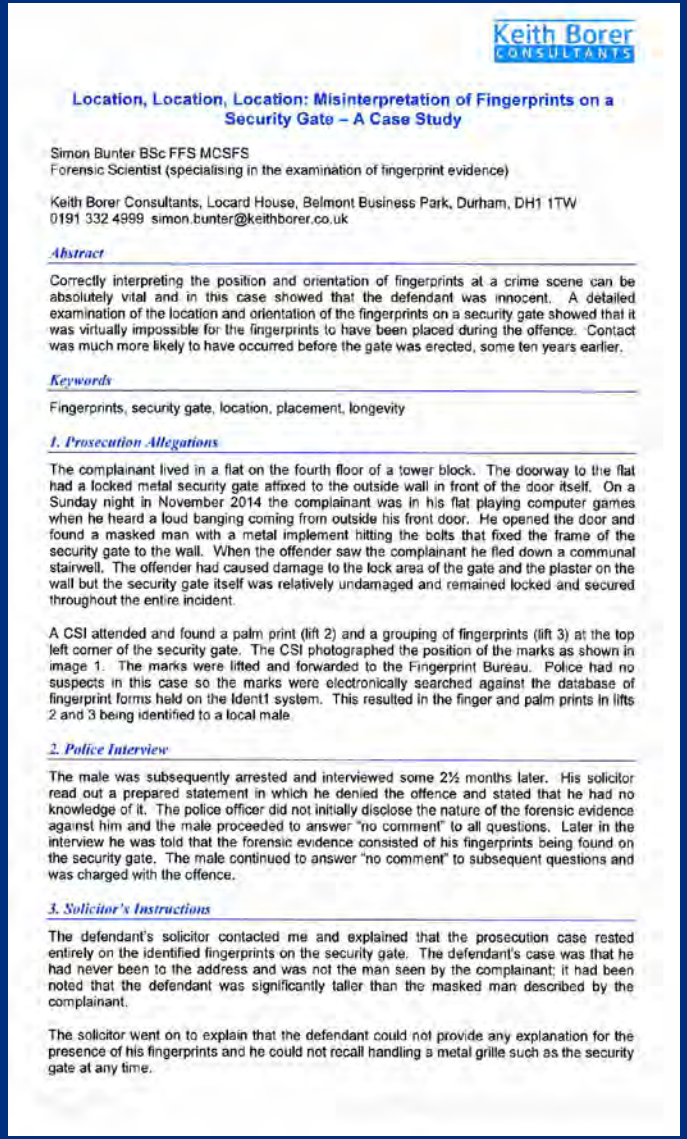


Results

- After deposition, a thin, uniform layer (called the “intermediate area”) of deposited material surrounds the main ridge deposit .
- It is likely composed of lower viscosity components that spread away from the main deposit and tend to evaporate/degrade over time.
- Likely candidates include fatty acids.
- Maximum area of the print deposit was measured at 137% of the original print (day 8) and a minimum of 69% (61 days).
- Maximum spread was measured at approximately 4 μm (day 30).
- Maximum thickness was recorded as approximately 4.7 nm (day 23).
- The deposit spread was more rapid on Formica (surface energy).

Introduction

- Bunter S. Location, Location, Location: Misinterpretation of Fingerprints on a Security Gate – A Case Study. Fingerprint Whorld 2017;42(163):8-25.
- This is a case report that documents the incorrect interpretation of fingerprints found at a crime scene.
- The location and orientation of the prints on a security gate were questioned – ultimately leading the prosecution to drop the charges.



Keith Borer CONSULTANTS

Location, Location, Location: Misinterpretation of Fingerprints on a Security Gate – A Case Study

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Abstract

Correctly interpreting the position and orientation of fingerprints at a crime scene can be absolutely vital and in this case showed that the defendant was innocent. A detailed examination of the location and orientation of the fingerprints on a security gate showed that it was virtually impossible for the fingerprints to have been placed during the offence. Contact was much more likely to have occurred before the gate was erected, some ten years earlier.

Keywords

Fingerprints, security gate, location, placement, longevity

1. Prosecution Allegations

The complainant lived in a flat on the fourth floor of a tower block. The doorway to the flat had a locked metal security gate affixed to the outside wall in front of the door itself. On a Sunday night in November 2014 the complainant was in his flat playing computer games when he heard a loud banging coming from outside his front door. He opened the door and found a masked man with a metal implement hitting the bolts that fixed the frame of the security gate to the wall. When the offender saw the complainant he fled down a communal stairwell. The offender had caused damage to the lock area of the gate and the plaster on the wall but the security gate itself was relatively undamaged and remained locked and secured throughout the entire incident.

A CSI attended and found a palm print (lift 2) and a grouping of fingerprints (lift 3) at the top left corner of the security gate. The CSI photographed the position of the marks as shown in image 1. The marks were lifted and forwarded to the Fingerprint Bureau. Police had no suspects in this case so the marks were electronically searched against the database of fingerprint forms held on the Ident1 system. This resulted in the finger and palm prints in lifts 2 and 3 being identified to a local male.

2. Police Interview

The male was subsequently arrested and interviewed some 2½ months later. His solicitor read out a prepared statement in which he denied the offence and stated that he had no knowledge of it. The police officer did not initially disclose the nature of the forensic evidence against him and the male proceeded to answer "no comment" to all questions. Later in the interview he was told that the forensic evidence consisted of his fingerprints being found on the security gate. The male continued to answer "no comment" to subsequent questions and was charged with the offence.

3. Solicitor's Instructions

The defendant's solicitor contacted me and explained that the prosecution case rested entirely on the identified fingerprints on the security gate. The defendant's case was that he had never been to the address and was not the man seen by the complainant; it had been noted that the defendant was significantly taller than the masked man described by the complainant.

The solicitor went on to explain that the defendant could not provide any explanation for the presence of his fingerprints and he could not recall handling a metal grille such as the security gate at any time.

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Image 2 – A mocked-up example showing the position of the defendant's right palm print and fingerprints from his right hand on the security gate.

Case

- The prosecution case rested entirely on the fingerprints identified on a security gate (allegedly deposited during an attempted burglary).
- All sides agreed that the prints in lifts #2 (defendant's right palm) and #3 (right middle, ring, and little fingers) were those of the defendant.
- The orientation and position of the prints in lift #3 were crucial (three prints on the upper horizontal bar of the gate – pointing upwards).
- The orientation appeared unnatural.
- The implication was that the person who deposited FP in lifts #2 and #3 most likely had done so prior to the attempted burglary/gate damage.

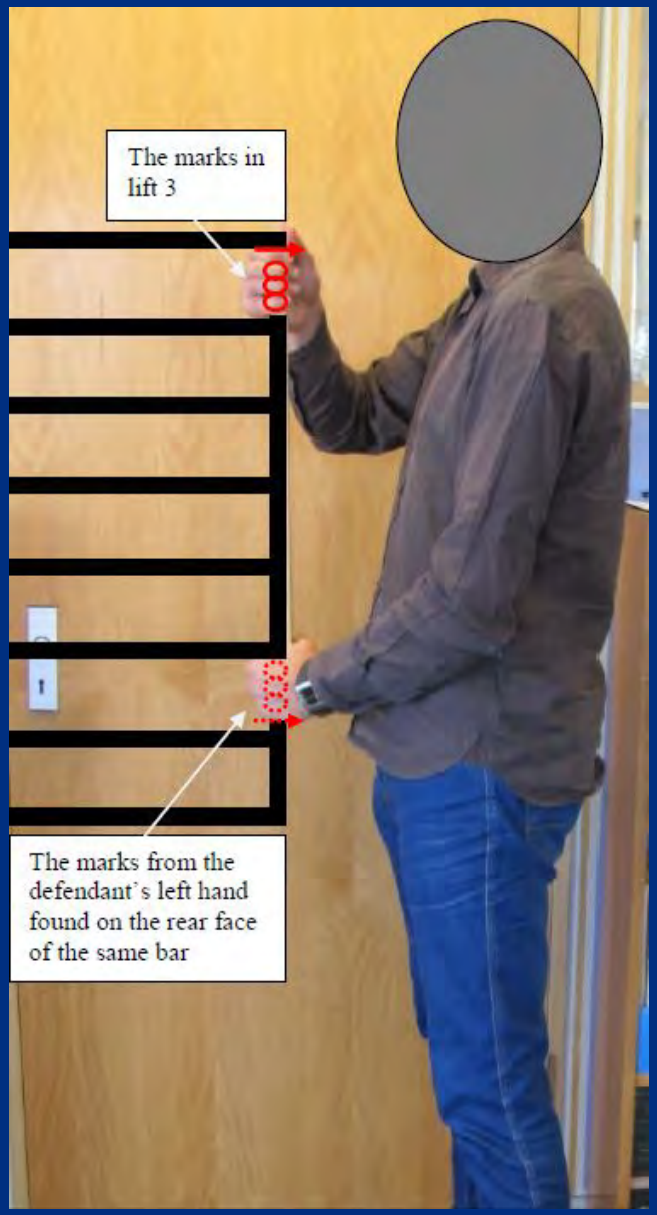
Case

- The more likely scenario was that the prints had been deposited while the gate had not been affixed to the building's wall.
- The gate had been installed about 10 years earlier and the defendant could not initially recall handling a metal security gate at that time.
- During the police interview the defendant noted that he had done some work that involved handling metal gates about 10 years ago.
- Simon Bunter's report stated that the position and orientation of the lifted prints were not consistent with touching the gate during the alleged offense.
- The findings were more consistent with the defendant's prior contact.

Case

- The mock scene photographs taken by the police officer to illustrate the attempted burglary scenario showed that the officer's fingers were in significantly different positions than the prints in lift #3.
- FP expert agreed that the fingers were in the incorrect position, but nonetheless agreed that the contact in lift #3 was still possible.
- At the scene, neither Simon nor the police officer could recreate the placement of both sets of impressions.
- The finding of additional prints from the defendant confirmed that this type of contact could not occur while standing on the ground outside the gate – it was consistent with carrying the gate (see next image).

Image 4 – The Police Investigating Officer's photograph which he incorrectly claimed to show his fingers in the same position as the prints in lift 3.



Case

- Defendant's prints on the gate appeared to be formed in the black paint or surface coating that had been applied during fabrication.
- The police fingerprint expert and Simon subsequently drafted a joint statement noting that the prints were consistent with the defendant having handled the gate prior to the offense.
- The prosecution dropped the case.
- What if 10 years ago, the defendant had left the palm mark in lift #2 but not the marks in lift #3?
- Would he have been found guilty of the offense?
- Has this scenario happened before? If so, how many times?

Introduction

- Liu et al. Detecting Latent Prints on Stone and Other Difficult Porous Surfaces via Indanedione/Zinc Chloride and Laser. J Forensic Sci Med 2016;2:203-207.
- The goal of this project was to determine whether or not indanedione could develop prints on stone, wood, and cotton surfaces.

Original Article

Detecting Latent Prints on Stone and Other Difficult Porous Surfaces via Indanedione/Zinc Chloride and Laser

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Abstract

Lasers and alternate light sources have been recognized as effective tools for latent print detection for over three decades. Luminescence often increases friction ridge contrast to reveal impressions otherwise undetectable. Indanedione/zinc chloride excited by a forensic light source is widely recognized as an effective process for developing latent prints on porous surfaces. This study was designed to evaluate the use of a combination of luminescence excitation and indanedione with zinc chloride to detect latent prints on stones, bricks, and similar difficult porous surfaces. The wavelengths evaluated included 400 nm (violet), 447 nm (blue), 532 nm (green), and 645 nm (red). Latent prints were deposited on a variety of porous surfaces including bricks, cement stones, wood, and cotton fabric, all commonly encountered at crime scenes in China. The surfaces were examined using white light (light-emitting diode flashlight) and laser light sources separately, both before and after treatment with indanedione/zinc chloride. The goal of this study was to evaluate various light sources for their effectiveness in detecting impressions developed by indanedione/zinc chloride on difficult porous surfaces. Results indicated that latent prints on some brick and cement stone surfaces may be effectively detected using 532 nm laser excitation after indanedione/zinc chloride processing.

Key words: Indanedione, laser, latent print, porous surface

Introduction

Light sources

Forensic light sources have been instrumental additions to the crime scene and exhibit examination disciplines for decades.[1] Biological evidence detected by luminescence excitation is often the most important evidence in crime scene investigation.[2]

In the 1970s, high-power (4–20 W) and low-power (50–300 mW) argon ion lasers operating in the 488–514.4 nm wavelengths, and copper vapor lasers operating at 510 nm (and sometimes also using the 578 nm wavelength) of the spectrum were widely used. In the 1980s, the advent of efficient dichroic filters able to effectively filter unwanted wavelengths emitted by xenon and indium arc lamps meant the replacement of lasers for most forensic science examinations not requiring fiber optics. Since the 1980s, advances in color light-emitting diode (LED) technology, and a variety of solid-state and semiconductor lasers, have meant a constantly changing array of forensic light source availability.

In the past decade, solid-state and semiconductor lasers with a variety of wavelengths used in forensic examinations have become more popular because of their compact size and weight, as well as their much stronger (than color LED light) output power.

Semiconductor lasers

Since 2007, many Chinese crime scene and forensic operations have utilized semiconductor lasers as their forensic light source of choice.[3] Four Lasearcher[4] semiconductor lasers with purple laser 400 nm, blue laser 447 nm, green laser 532 nm, and red laser 635 nm have been used in this study.

Chemistry

The chemical composition of latent print residue usually includes eccrine gland secretions (amino acids, proteins,

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Overview

- Four light sources used (Lasearcher semiconductor lasers): 400 nm (purple); 447 nm (blue); 532 nm (green); and 635 (red).
- Substrates included: brick, cement stone, wood, and cotton.
- All items treated with indanedione-zinc (0.1% w/v).
- Items treated with IND/Zn were heated in an oven at 80°C for 10-20 minutes.
- Ten donors; natural prints deposited.

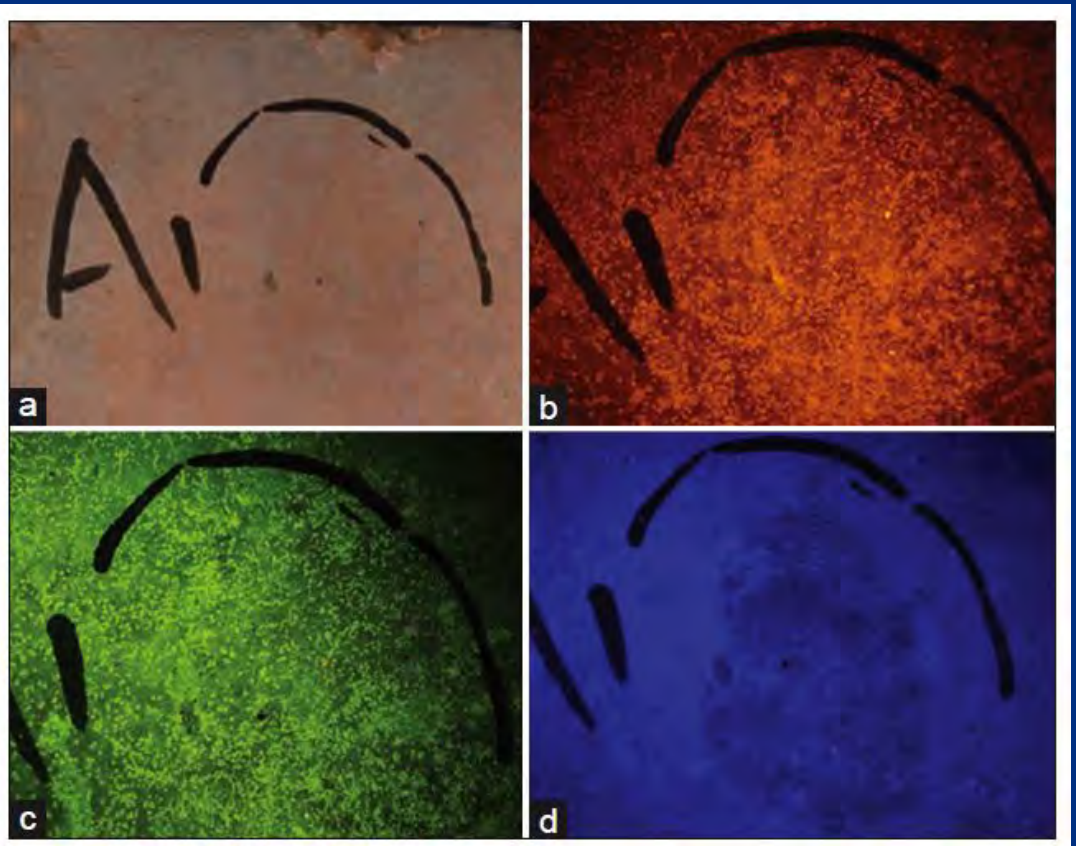

Figure 1: The same latent print on the brick surface photographed by: (a) white light-emitting diode; (b) 532 nm photographed through a cutoff filter; (c) 447 nm photographed through a cutoff filter; (d) 400 nm photographed through a cutoff filter. In latent print detected by light-emitting diode, 532 nm and 447 nm, it is hard to see any ridge detail, but 400 nm can find a few ridge details

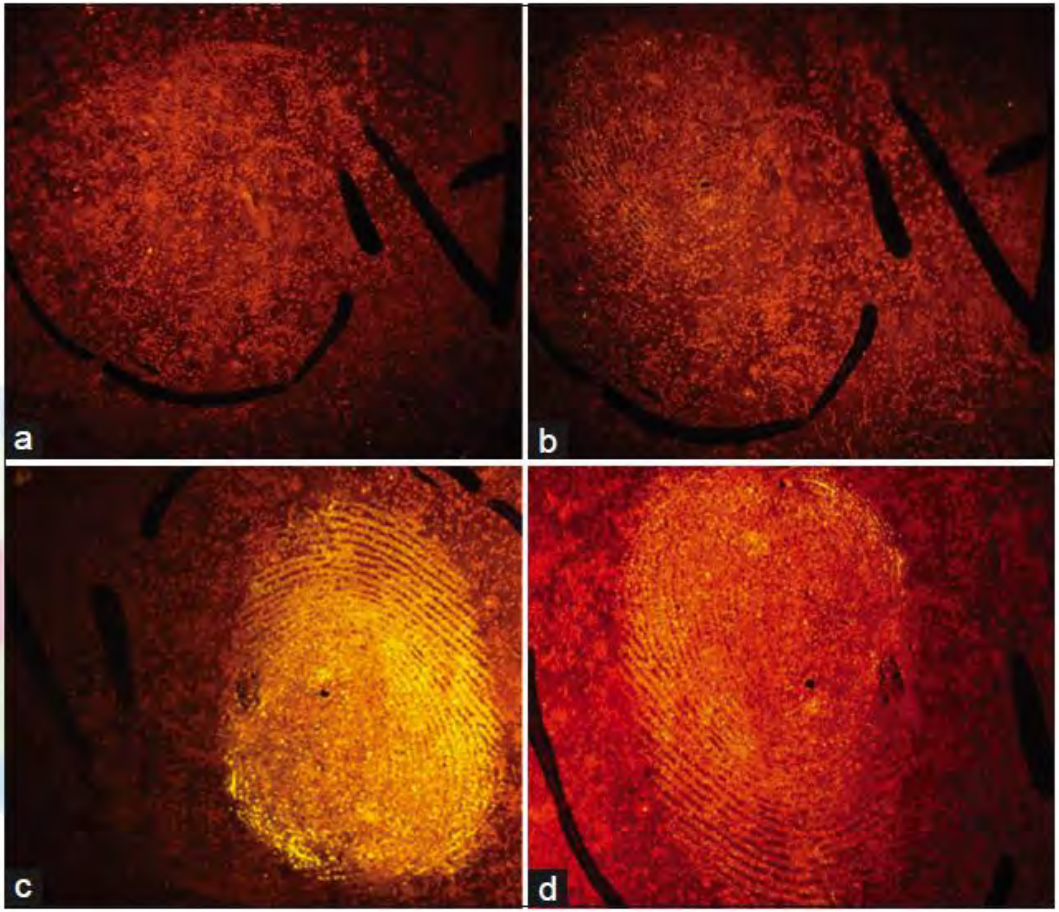

Figure 3: The same latent print on a brick treated with: (a) 532 nm photographed immediately after processing; (b) 3 hours with indanedione at 532 nm; (c) 3 days with indanedione at 532 nm; and (d) 30 days with indanedione at 532nm

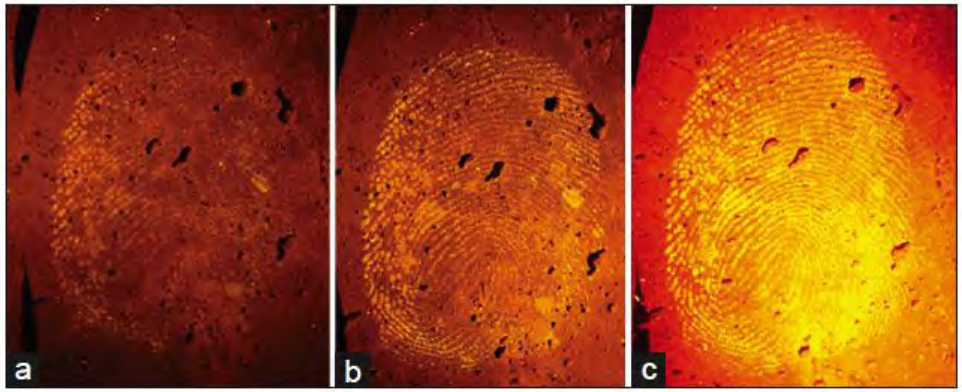

Figure 6: The same latent print on cement stone treated with indanedione/zinc chloride, photographed with 532 nm illumination through a cutoff filter: (a) 3 h after processing; (b) 3 days after processing; (c) 30 days after processing

Table 2: Latent prints treated with indanedione/zinc chloride

	Brick	Cement stone	Wood	Cotton
LED	N/A	N/A	N/A	N/A
Green laser (532 nm)	Strong	Strong	Strong	Strong
Blue laser (447 nm)	N/A	N/A	N/A	Weak
Purple laser (400 nm)	Weak	N/A	N/A	N/A
Red laser (635 nm)	N/A	N/A	N/A	N/A

LED: Light-emitting diode, N/A: Not available

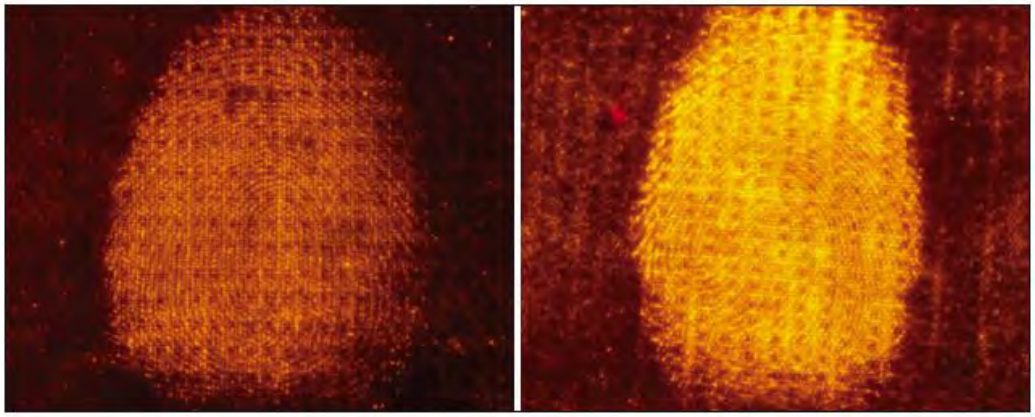

Figure 9: Fingerprint on cotton fabric surface

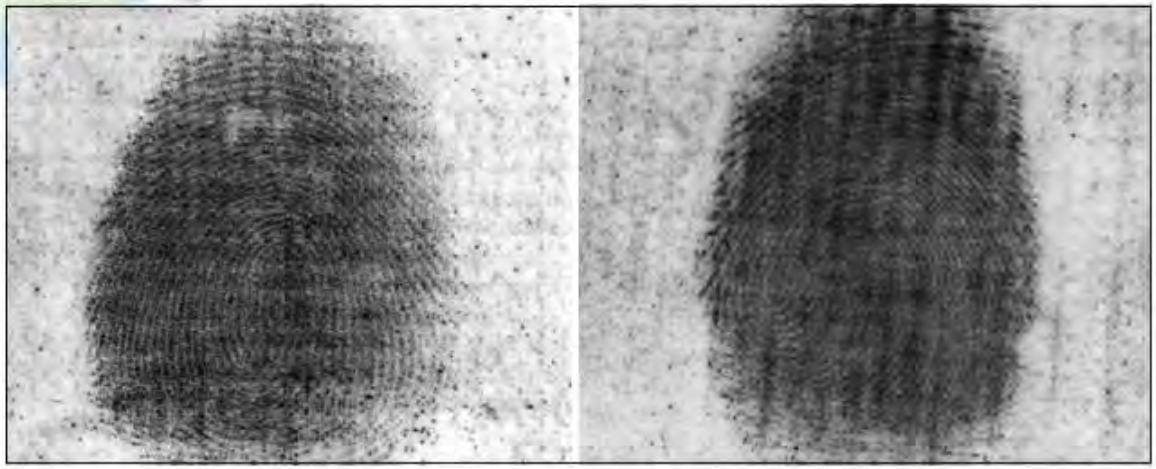

Figure 10: Fingerprint images adjusted by Fourier transform image processing on cotton fabric surface

Results

- Most untreated latent prints showed no ridge detail under white light or laser; image enhancement was needed to capture any ridge detail.
- Intensity of inherent fluorescence depends on: texture of substrate; composition of LP; light source wavelength/power; imaging factors.
- Bricks: fluorescence best at 532 nm; best captured after 3 days.
- Cement stone: fluorescence best at 532 nm.
- Wood (10 types): only 4 prints recovered using IND at 532 nm; wood grain interfered with image (5-10 µm between grain ridges).
- Cotton: two prints recovered using 532 nm laser; 6 minutiae found in image enhanced prints (to remove fabric pattern).

Introduction

- Dalrymple B, Almog J. Extending Detection Reach with a New Narrow Bandpass Filter. J Forensic Ident 2017;67(2):206-225.
- The goal of this technical note was to introduce the use of narrow bandpass filters in addition to conventional orange bandpass filters for recording untreated and treated prints.

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Technical Note

Extending Detection Reach with a New Narrow Bandpass Filter

Brian Dalrymple [1]
Joseph Almog [2]

Abstract: Fingerprints have been detected and photographed by fluorescence for four decades. The technique has required the use of a barrier filter, in most cases orange, to block the light source reflection and isolate fluorescence. In some cases, however, the substrate also exhibits fluorescence, which can partially or totally obscure the fingerprint. A new narrow bandpass filter, used in combination with the standard barrier filter, can add significantly to both the extent and clarity of inherently and chemically treated fluorescing fingerprints. Moreover, in certain borderline cases, the chemical solution alone may be insufficient, but tailored optics can save the situation by converting an otherwise useless stain to an identifiable impression.

History of Luminescence Detection

Luminescence detection of untreated fingerprints began in 1977 [1] and relied on intrinsic fluorescence. This procedure has continued to be part of latent print detection protocol to the present time. Early chemical extensions [2, 3] did not achieve full effectiveness until the introduction of dye-staining combined with cyanoacrylate fuming [4]. As with any detection method, the impressions of greatest significance in an investigation are not necessarily the easiest to visualize and photograph. In the authors' experience, many of the latent prints that ultimately were most pivotal to investigations were observed and photographed at the threshold of visual perception.

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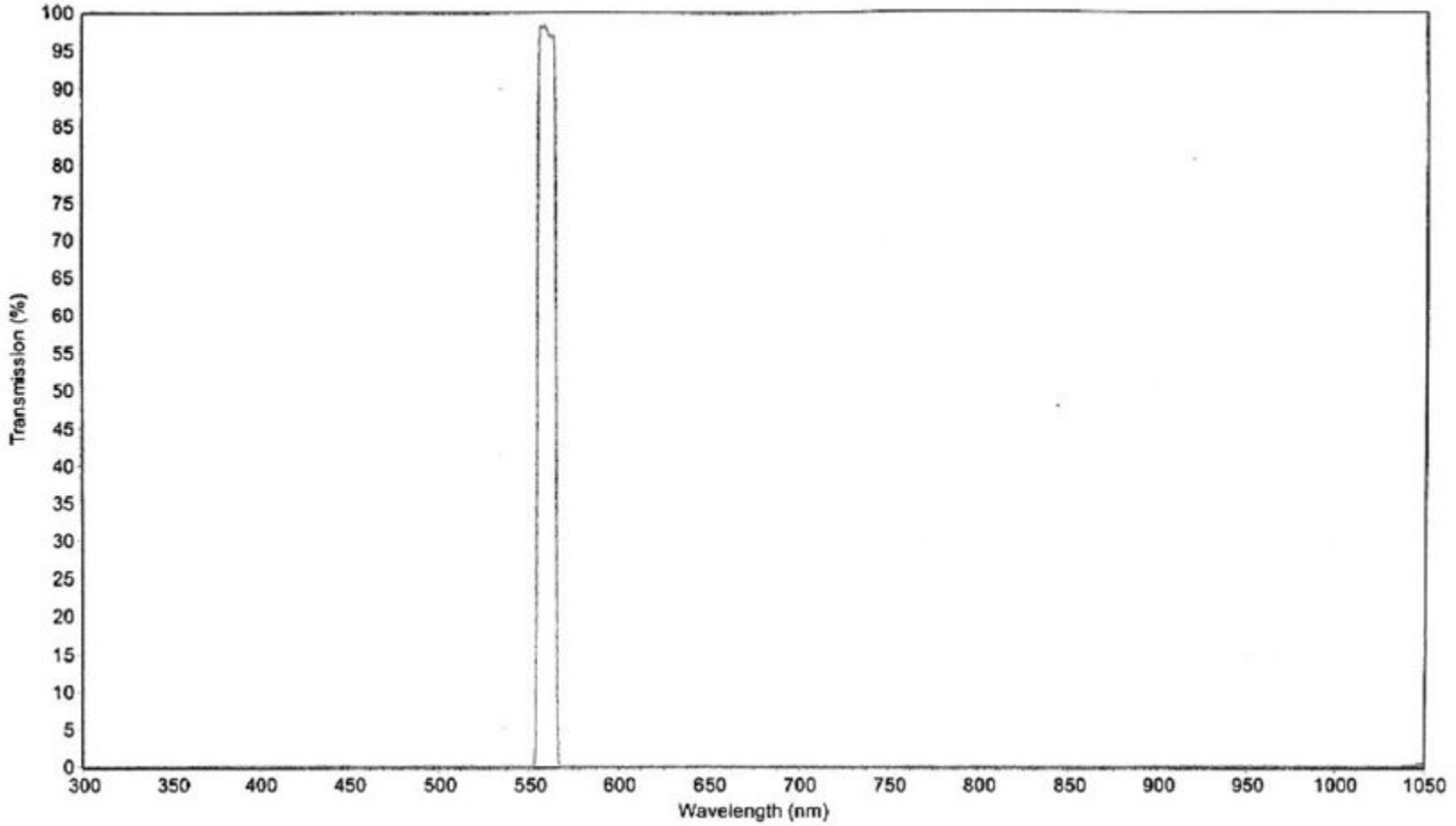
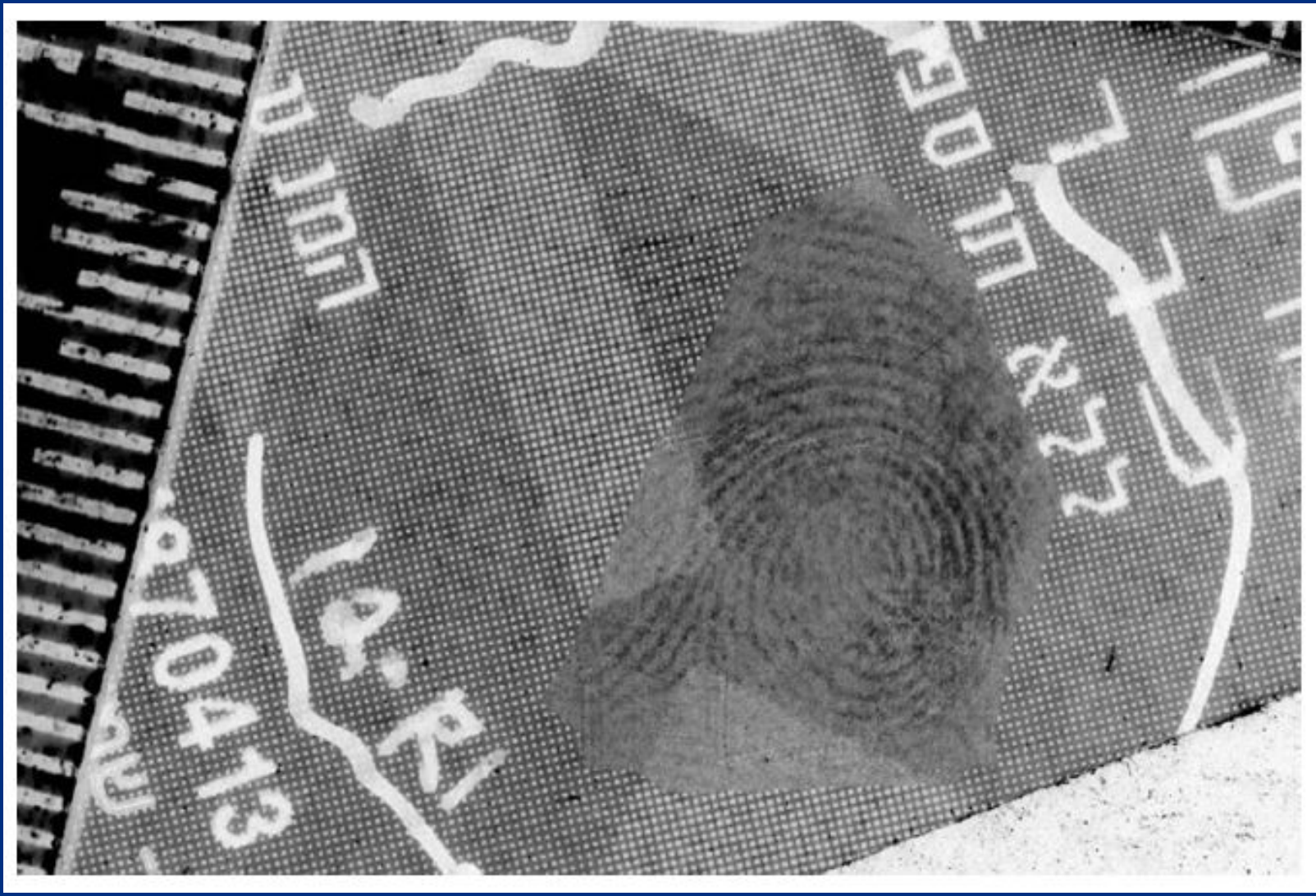
Overview

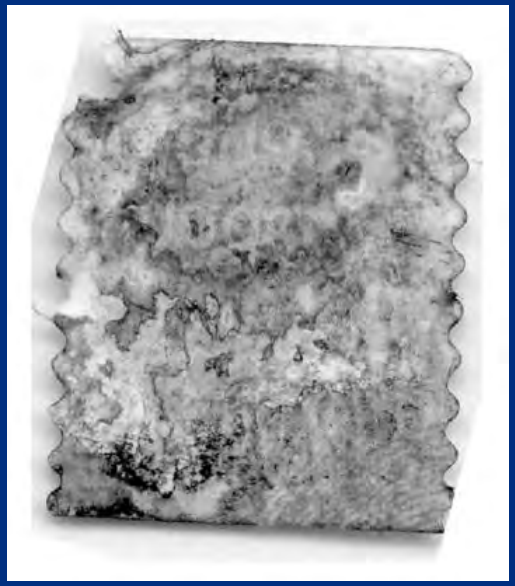
- The orange barrier filter tends to transmit substrate fluorescence in the orange/red part of the spectrum (both treated and untreated prints).
- Optical coating technology allows for the creation of high performance interference filters that pass/reject only a few nm of incident light.
- Melles Griot 03-FIV-079 filter (550 nm peak transmission/10 nm bandwidth); needed orange BP filter (leak in green); no longer made.
- Arrowhead Forensics FF-1.0 filter (560 nm peak trans/10 nm BW).
- Railway tickets (thermal) and student exam papers used.
- TracER 532 nm laser (4 W) and Flare Plus 2 505 nm LED used.

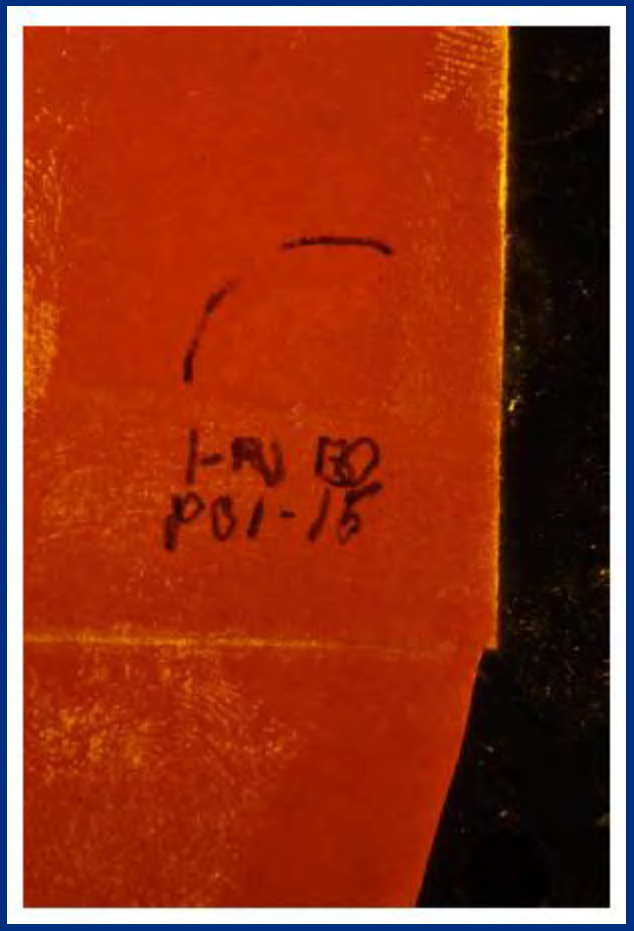

Transmission (%)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
Wavelength (nm)

Results

- Using orange barrier filter in conjunction with FF-1.0 increased the optical density and required longer exposure times to capture images.
- Example 1: Untreated print; 532 nm laser/orange barrier filter; Photoshop – green channel; orange filter/FF-1.0 used in combination; grayscale conversion; Image Pro Premier (FFT pattern editing).
- Case Report: letter in manila envelope; stamp removed and treated with Liquinox; treated with IND/532 nm laser/orange BP filter – faint detail; narrow bandpass filter/orange BP filter – clear detail (detail appeared to have been transferred from the adhesive side of stamp).
- The narrow bandpass filter must be used with the orange BP filter when the 532 nm laser is used; increase S/N ratio – improves detail.







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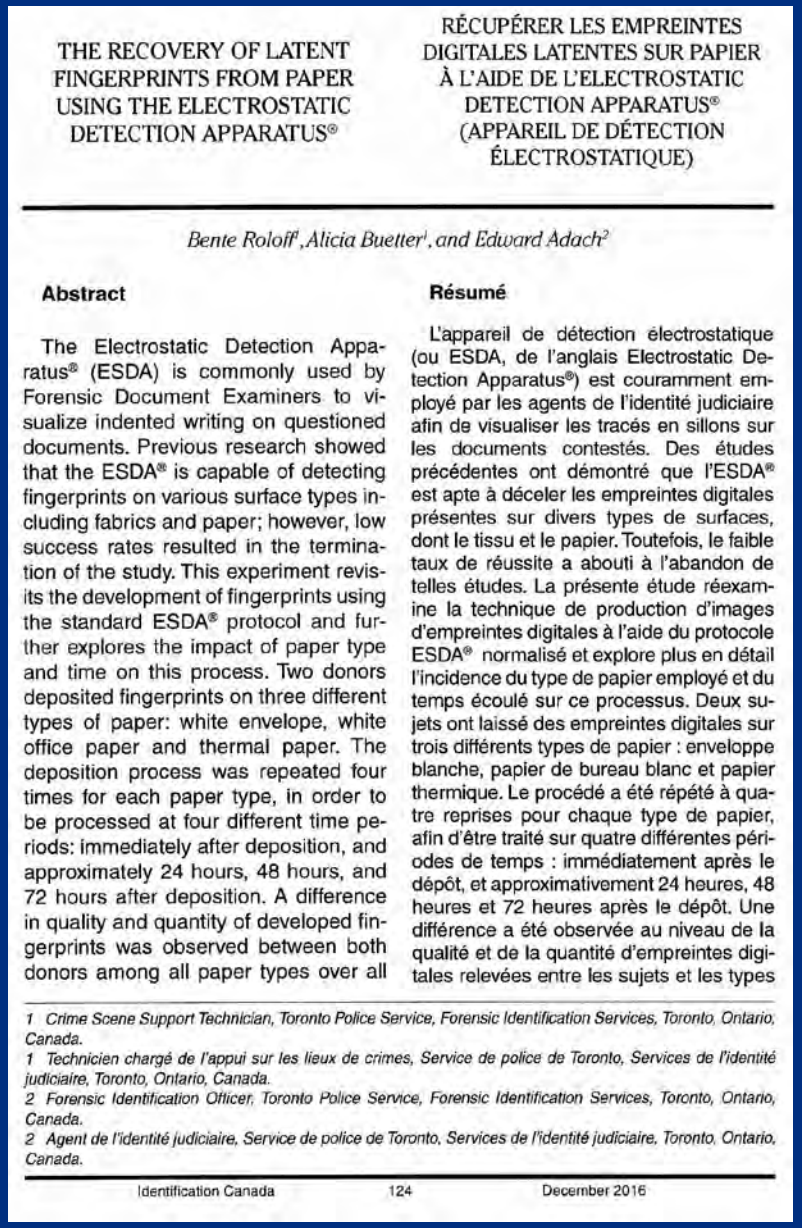
Introduction

- Roloff B, Buetter A, Adach E. The Recovery of Latent Fingerprints from Paper Using the Electrostatic Detection Apparatus. Ident Canada 2016;124-144.
- The goal of this effort was to determine whether or not the ESDA method could visualize latent prints after 24 hours.



THE RECOVERY OF LATENT FINGERPRINTS FROM PAPER USING THE ELECTROSTATIC DETECTION APPARATUS®

RÉCUPÉRER LES EMPREINTES DIGITALES LATENTES SUR PAPIER À L'AIDE DE L'ELECTROSTATIC DETECTION APPARATUS® (APPAREIL DE DÉTECTION ÉLECTROSTATIQUE)

Bente Roloff[1], Alicia Buetter[1], and Edward Adach[2]

Abstract

The Electrostatic Detection Apparatus® (ESDA) is commonly used by Forensic Document Examiners to visualize indented writing on questioned documents. Previous research showed that the ESDA® is capable of detecting fingerprints on various surface types including fabrics and paper; however, low success rates resulted in the termination of the study. This experiment revisits the development of fingerprints using the standard ESDA® protocol and further explores the impact of paper type and time on this process. Two donors deposited fingerprints on three different types of paper: white envelope, white office paper and thermal paper. The deposition process was repeated four times for each paper type, in order to be processed at four different time periods: immediately after deposition, and approximately 24 hours, 48 hours, and 72 hours after deposition. A difference in quality and quantity of developed fingerprints was observed between both donors among all paper types over all

Résumé

L'appareil de détection électrostatique (ou ESDA, de l'anglais Electrostatic Detection Apparatus®) est couramment employé par les agents de l'identité judiciaire afin de visualiser les tracés en sillons sur les documents contestés. Des études précédentes ont démontré que l'ESDA® est apte à déceler les empreintes digitales présentes sur divers types de surfaces, dont le tissu et le papier. Toutefois, le faible taux de réussite a abouti à l'abandon de telles études. La présente étude réexamine la technique de production d'images d'empreintes digitales à l'aide du protocole ESDA® normalisé et explore plus en détail l'incidence du type de papier employé et du temps écoulé sur ce processus. Deux sujets ont laissé des empreintes digitales sur trois différents types de papier : enveloppe blanche, papier de bureau blanc et papier thermique. Le procédé a été répété à quatre reprises pour chaque type de papier, afin d'être traité sur quatre différentes périodes de temps : immédiatement après le dépôt, et approximativement 24 heures, 48 heures et 72 heures après le dépôt. Une différence a été observée au niveau de la qualité et de la quantité d'empreintes digitales relevées entre les sujets et les types

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Identification Canada 124 December 2016

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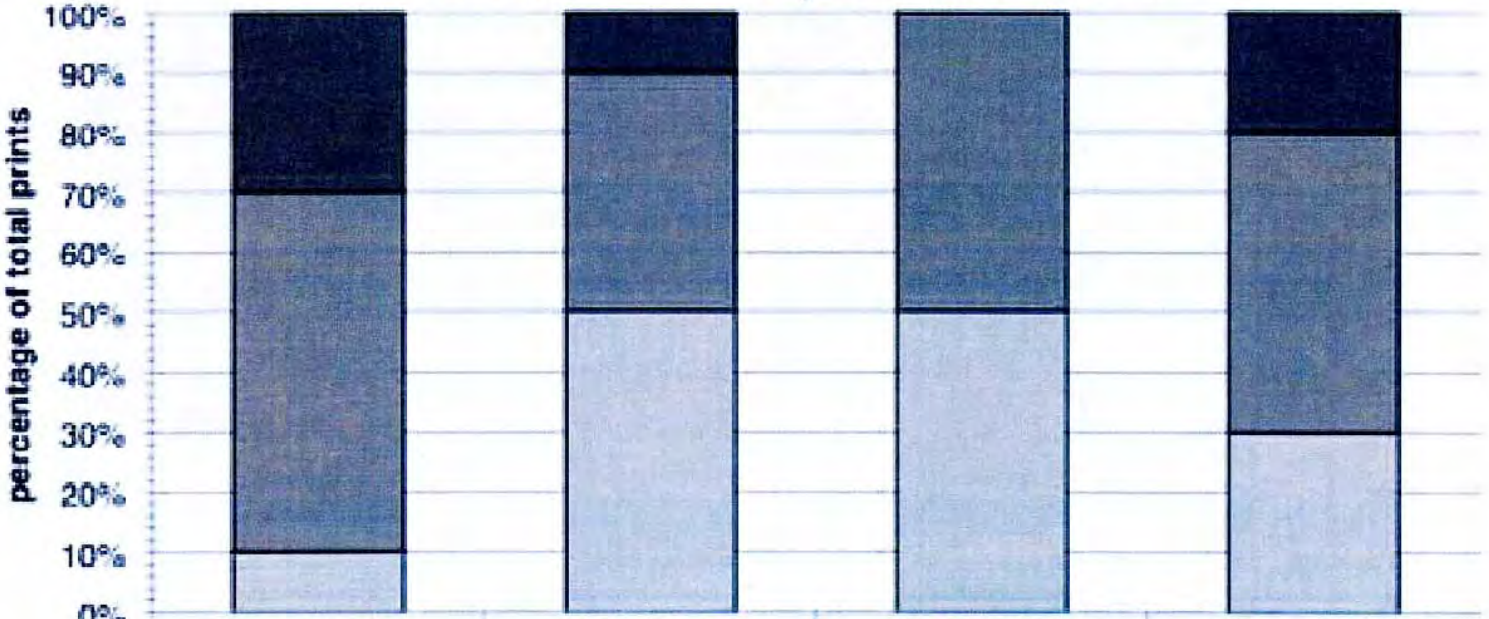
Overview

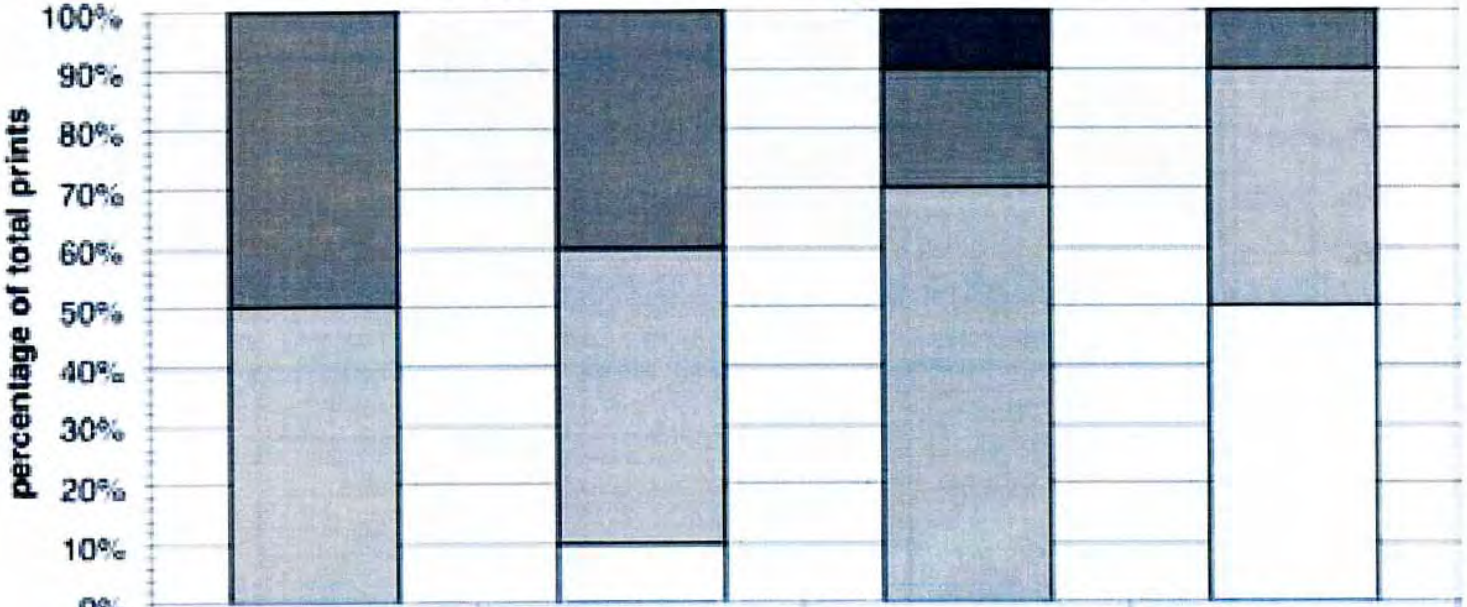
- In the 1970s, the UK PSDB found that ESDA could reveal prints on fabrics and paper, but only up to 24 hours old.
- However, in 2004, a latent print was developed on a month old robbery demand note (New Hampshire State Police) using an ESDA-like system (vacuum box).
- White envelope; white office, and thermal papers were used.
- Two donors (females aged 20-30); 240 total prints (120 per donor).
- Prints aged for 24, 48, and 72 hours.
- No pre-humidification was used (standard ESDA practice – 2-3 minutes in a saturated water-filled chamber).

White Envelope - Donor B



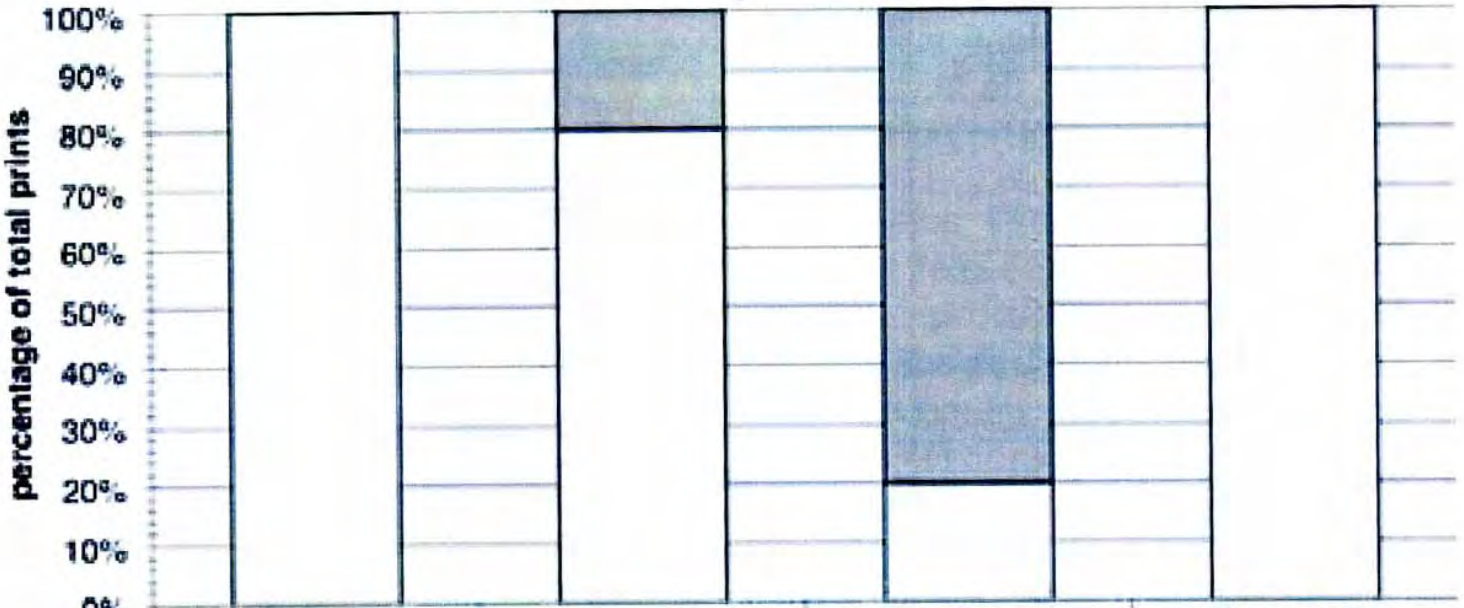
	Immediate after deposition	24 hours after deposition	48 hours after deposition	72 hours after deposition
Grade 4	0%	0%	0%	0%
Grade 3	30%	10%	0%	20%
Grade 2	60%	40%	50%	50%
Grade 1	10%	50%	50%	30%
Grade 0	0%	0%	0%	0%

White Office Paper - Donor B



	Immediate after deposition	24 hours after deposition	48 hours after deposition	72 hours after deposition
Grade 4	0%	0%	0%	0%
Grade 3	0%	0%	10%	0%
Grade 2	50%	40%	20%	10%
Grade 1	50%	50%	70%	40%
Grade 0	0%	10%	0%	50%

Thermal Paper - Donor B



	Immediate after deposition	24 hours after deposition	48 hours after deposition	72 hours after deposition
Grade 4	0%	0%	0%	0%
Grade 3	0%	0%	0%	0%
Grade 2	0%	0%	0%	0%
Grade 1	0%	20%	80%	0%
Grade 0	100%	80%	20%	100%

Results

- Thermal paper was the poorest performing substrate.
- Original UK PSDB guidance of 24 hour limit contradicted.
- Considering all paper samples, 67% showed no fingerprint development after 72 hours.
- Single capacitance theory suggests that FP can hold an electric charge due to its water content (which weakens as water evaporates).
- Amino acids could also hold charge; inter-subject/donor AA variability could explain why results from donors A and B were different.

Introduction

- Morrison GS. Special Issue on Measuring and Reporting the Precision of Forensic Likelihood Ratios: Introduction to the Debate. Sci Just 2016;56:371-373.
- Science & Justice, volume 56, issue 5, special section
- Seven position papers published; responses published in Science & Justice, volume 57, issue 1.

Science and Justice 56 (2016) 371–373

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journal homepage: www.elsevier.com/locate/scijus

ELSEVIER

Special issue on measuring and reporting the precision of forensic likelihood ratios: Introduction to the debate☆

CrossMark

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Likelihood ratio
Precision
Reliability
Accuracy
Validity

ABSTRACT

The present paper introduces the *Science & Justice* virtual special issue on measuring and reporting the precision of forensic likelihood ratios – whether this should be done, and if so how. The focus is on precision (aka reliability) as opposed to accuracy (aka validity). The topic is controversial and different authors are expected to express a range of nuanced opinions. The present paper frames the debate, explaining the underlying problem and referencing classes of solutions proposed in the existing literature. The special issue will consist of a number of position papers, responses to those position papers, and replies to the responses.

1. Introduction

The papers gathered in this special issue of *Science & Justice* represent an open debate on the topic of whether the precision of forensic likelihood ratios should be measured and reported to the courts, and if so how. This is a controversial issue, with authors expressing contrary opinions. Some believe that the very concept of the precision of likelihood ratios is not appropriate, whereas others believe that measuring and reporting the precision of likelihood ratios is essential. In addition, even authors who mostly agree with each other differ on details. The debate has been ongoing for a number of years, but much of it has been hidden: Reviewers of submitted manuscripts complaining that precision has or has not been measured, and authors justifying their choices in rebuttal letters.

The present special issue aims to bring the debate out into the open, to lead to a better understanding of the reasons behind different authors' opinions, and potentially even to lead to some degree of consensus. A precursor to the present journal special issue took place at the European Academy of Forensic Sciences (EAFS) Conference in Prague in September 2015, where several presenters (Geoffrey Stewart Morrison; James M Curran; Colin GG Aitken; Peter Vergeer with Ivo Alberink, Annabel Bolck, Marjan Sjerps, and Reinoud Stoel; and Didier Meuwly) gave a series of brief presentations on this topic. This virtual special issue (VSI) of *Science & Justice* had an open call for papers which welcomed and encouraged submissions both from authors who did not present at the EAFS conference and from those who did.

The present introductory paper is intended to be neutral, framing the debate but not taking a position in the debate. An initial draft of this introduction was written before the initial call for papers went out, and (except for corrections of any typographical errors, etc.) the final version was written before any of the submitted papers were received.

The initial position papers will be published online as a single block, at which point a second open call for papers will go out requesting responses to those position papers. Authors of the position papers will subsequently be given the opportunity to reply to the response papers. All the position, response, and reply papers will be collected together online.

2. Precision versus accuracy

First, we wish to make it clear that all contributors to the current debate agree that the likelihood ratio framework is the logically correct framework for the evaluation of evidence. Next, we wish to make clear what it is we mean by precision. Fig. 1 shows four targets that four archers have shot at. Two archers each have a tight grouping of arrows – these archers are precise. Two other archers have a wide spread in the location of their arrows – these archers are not precise. In each of these pairs, one archer is also accurate, the average location of their arrows is near the centre of the target, and the other is not accurate, the average

☆ This paper is part of the Virtual Special Issue entitled: Measuring and Reporting the Precision of Forensic Likelihood Ratios, [http://www.sciencedirect.com/science/journal/13550306/vsi], Guest Edited by G. S. Morrison.

E-mail address: geoff-morrison@forensic-evaluation.net.

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1355-0306/

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FURTHER READING

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